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Analysis of roof snow load case studies

Uniform loads

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January 1983

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M. O'Rourke, P. Koch and R. Redfield

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Roof snow load case studies gathered throughout the United States over a three-year period are analyzed. The objective of the analysis is to determine a relationship between the snow load on the ground and the corresponding uniform snow load on flat and sloped roofs. The main parameters considered are the thermal characteristics of the roof, the roof slope and the exposure of the structure. Exposure has the strongest effect on the ratio of ground to roof snow loads. Comparisons are made with existing and proposed building codes and standards.

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PREFACE

This report was prepared by Michael O'Rourke, Associate Professor, Civil Engineering, Rensselaer Polytechnic Institute; Paul Koch, Structural Engineer, J. Ray McDermott Co.; and Robert Redfield, Research Civil Engineer, Geophysical Sciences Branch, Research Division, U.S. Army Cold Regions Research and Engineering Laboratory.

This study was funded under DA Project 4K078012AAM1, *Facilities Investigation and Studies Program* (O&M, A); Task 00; Work Unit 101, *Snow Load Criteria for the Contiguous United States–Joint Study (Army, Navy, USAF).*

The technical content of the report was reviewed by Dr. Ronald Sack, Department of Civil Engineering, University of Idaho and Wayne Tobiasson of CRREL.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

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These conversion factors include all the significant digits given in the conversion tables in the ASTM *Metric Practice Guide* (E 380), which has been approved for use by the Department of Defense. Converted values should be rounded to have the same precision as the original (see E 380).

Multiply	*By*	*To obtain*
inch	0.0254*	metre
pound/ft^2	4.882428	kilogram/$metre^2$
pound/ft^3	16.01846	kilogram/$metre^3$

* Exact.

ANALYSIS OF ROOF SNOW LOAD CASE STUDIES
Uniform loads

M. O'Rourke, P. Koch and R. Redfield

INTRODUCTION

Snow is the governing structural design load for roofs in many portions of the United States. The importance of establishing an appropriate design load becomes apparent after studying statistics on roof collapses gathered by insurance companies.* In the past, snow loads and rain loads on inadequately drained roofs have caused about the same number of roof collapses. The dollar losses from each were also about equal. More recently, due to heavy snowfalls in portions of the United States, snow-related collapses have exceeded those due to rain loads. Roofs of more than 200 buildings collapsed due to snow during the 1977-78 winter, with damage in excess of $40,000,000.† The heavy snow in the Midwest during the 1978-79 winter caused about 140 building failures in the Chicago metropolitan area (Bilandic 1979) and over 100 failures in Wisconsin (Somerson 1979).

Factory Mutual Insurance Company, a company that insures approximately 60% of the industrial buildings in the United States, reported† that during the period from 1974 to 1978, snow loads accounted for approximately 55% of the roof losses; 20% were due to rain, and the remaining 25% were due to structural deterioration, excessive equipment loads and other causes. Drifting loads on multilevel roofs accounted for about 75% of the snow-related failures.

Most building codes and standards include requirements on how much snow a roof should be designed to hold. Because ground snow data are available, the usual starting point for determining a design roof snow load is to determine the ground snow load. The probability that the maximum ground snow load will exceed a particular value in a given period of years may be calculated by fitting the set of annual maxima of recorded ground snow loads for a particular location to an appropriate extreme value distribution.

For example, Thom (1966) used a log-normal distribution to fit the series of annual maxima of the water equivalent of ground snow. The 50-year-mean recurrence intervals for ground snow loads generated by Thom are the basis for the ground snow load map in the 1972 American National Standard (ANSI 1972) The ground load provisions for the 1982 American National Standard (ANSI 1982) are based upon more recent work by Tobiasson and Redfield (in press), who also used a log-normal distribution to obtain 50-year-mean recurrence intervals for ground loads for the United States. A Gumbel extreme-value distribution was used in establishing ground loads for the National Building Code of Canada (National Research Council 1977).

There is very little information on the variation of roof snow loads across the United States. From a structural engineering viewpoint, however, the snow load on the roof is the important design parameter. To compare ground snow loads with roof snow loads, most building codes and standards use a ratio termed the ground-to-roof conversion factor.

The purpose of this report is to use data on ground and roof snow loads to determine the conversion factor for uniform snow loads on flat and sloped roofs, specifically how the thermal characteristics of the roof, the slope of roof, and the exposure of the structure affect this factor.

DATA BASE

The data analyzed in this report were collected during a three-year research program sponsored by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL). Researchers from eight universities in the Northeast, Midwest, and Northwest measured roof and ground snow loads for 199 structures (Table 1), resulting in

* Personal communication with M. Burke, Factory Mutual Insurance Co., and V. Hassell, Kemper Insurance Co.
† Personal communication with M. Burke.

Table 1. Number of structures surveyed by participating universities.

University	1975-76	1976-77	1977-78
University of Colorado	-	-	31
Michigan Technological University	-	20	21
Oregon State University	-	15	15
Rochester Institute of Technology	-	20	-
Rensselaer Polytechnic Institute	21	51	44
South Dakota State University	-	-	11
State University of New York at Buffalo	-	-	21
Washington State University/University of Idaho	-	-	14
Total*	21	106	157

*For some structures, roof snow load case studies are available for two or three consecutive years. The sum of the structures monitored for individual winters is therefore larger than 199.

the largest collection of information on roof snow loads in the United States. Appendix A lists the reports about these case studies.

Each researcher was directed to select roofs in his area that covered a range of exposure, geometry and thermal characteristics. This resulted in the selection of roofs that fell into similar categories that spanned the northern U.S. from coast to coast. The researchers were provided with snow density kits and instructions on how to measure ground and roof snow.

Information about the structures is contained in Appendix B. Each structure is identified by a structure number (SN). Since some structures had two or more roofs, each roof is identified by a roof number (RN). For example, the RN is 1 for the upper roof of a multilevel building, while the RN is 2 for the lower level roof of the same structure. Hence, although there are only 199 structures, there are 253 roofs in the data base.

The slope of each roof in degrees and the roof geometry (RG) are also listed in Appendix B. The RG parameter classifies the roofs according to the type of snow load observed. The RG is 1 where relatively uniform roof snow loads were observed. Included in this category are flat single-level roofs, sloped roofs and the upper-level roofs of multilevel structures. Of the 253 roofs in the data base, 183 have an RG of 1.

When drifting causes non-uniform loadings, the RG is 2 (when the drifting is due to parapets) or 3 (when the drifting is on lower-level roofs of multilevel buildings). The data from roofs in these categories are considered in a separate report (Von Bradsky 1980) and are listed here only to show the extent of the data base.

The structure's exposure to wind was identified by the exposure rating (EX), which is a function of the location of the roof relative to its surroundings. The exposure rating considers shelter from trees, buildings and other obstructions. EX is 1 for sheltered roofs, 2 for semisheltered roofs and 3 for windswept roofs. Since the exposure rating is a subjective measure, two individuals might disagree on a particular rating. Fortunately, the contract manager for the CRREL research project visited each of the participating universities and most of the structures included in this study, assuring uniformity in the exposure ratings. Figure 1 shows typical sheltered, semisheltered and windswept roofs.

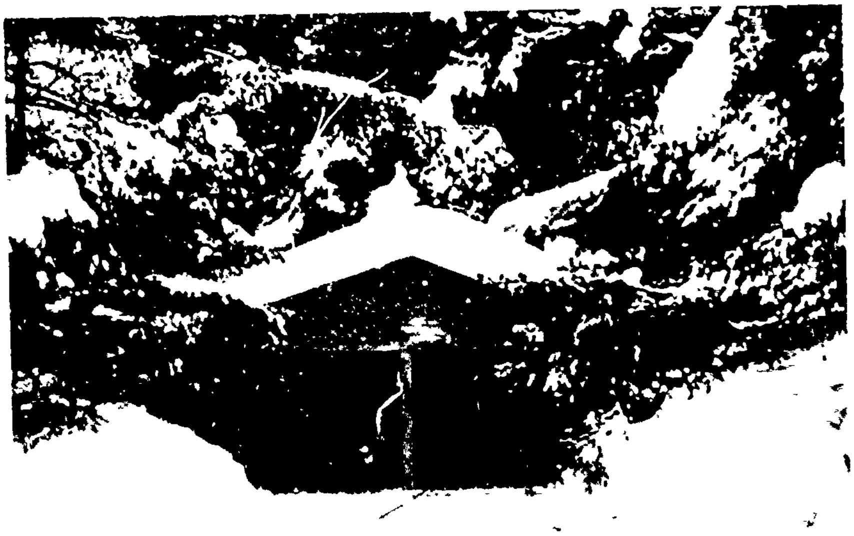
The final roof characteristic contained in Appendix B is the heating parameter H. Since some reduction in roof snow load due to heat flow through the roof is likely, structures are identified as unheated (H is 1) or heated (H is 2).

Information about the characteristics of the 253 roofs surveyed is summarized in Table 2. Notice that more than half the roofs are windswept, while nearly 75% are heated.

Ground and roof snow loads were measured during each visit to a particular structure. Standard measurement techniques were employed by all researchers.

Table 2. Summary of the structural characteristics for the 199 structures in the data base.

	Percent of roofs
Roof geometry	
1 (uniform loads)	73
2 (parapet drifting loads)	15
3 (multilevel roof drifting loads)	12
Exposure rating	
1 (sheltered)	11
2 (semisheltered)	31
3 (windswept)	58
Heating parameter	
1 (unheated)	28
2 (heated)	72



a. Sheltered

b. Semisheltered

Figure 1. Typical roofs

c. Windswept.

Figure 1 (cont'd). Typical roofs.

resulting in uniform data for all roofs in the study. Appendix C gives the structure number, the roof number and the date of the visit, along with the average depth of the ground snow h_g and the roof snow h_r and the average density of the ground snow γ_g and the roof snow γ_r.

CONVERSION FACTOR

Structural engineers are interested in conversion factors relating the roof snow load to the ground snow load. It is possible to calculate a conversion factor C_v for an individual structure from the data for a particular *visit* to that structure:

$$C_v = \frac{h_r \cdot \gamma_r}{h_g \cdot \gamma_g} . \qquad (1)$$

The C_v values vary widely for a particular structure during a given year because the mechanisms that deplete or remove snow from the roof (i.e. wind and, to a lesser extent, thermal effects) differ from the mechanisms that affect snow on the ground. This is illustrated in Figure 2, which shows the variation in ground and roof snow loads for Structure 67 during the 1976-77 winter. Notice that the maximum roof load occurs around the beginning of January, while the maximum ground load doesn't occur until the middle of February. As a result, the C_v values plotted in the upper portion of Figure 2 are much higher during the first half of the winter than during the second half.

The maximum roof load occurred before the maximum ground load in about half the case studies. In approximately 40% of the cases, the maximum roof and ground loads were observed during the same visit, while in only about 10% of the cases did the maximum roof load occur after the maximum ground load.

Besides the variability, the major drawback with C_v is that it does not supply the information needed. Structural engineers have probabilistic estimates for the maximum ground load and want estimates for the maximum roof load. That is, the conversion factor of interest is the ratio between the maximum roof load and the maximum ground load. This quantity will be referred to as C_m, the conversion factor between maxima:

$$C_m = \frac{(h_r\gamma_r)_{max}}{(h_g\gamma_g)_{max}} \qquad (2)$$

where $(h_r\gamma_r)_{max}$ is the maximum roof load for a particular structure recorded during a given year and $(h_g\gamma_g)_{max}$ is the maximum ground load measured in the immediate vicinity of the structure during that year. Thus, there is a separate C_v value for a particular

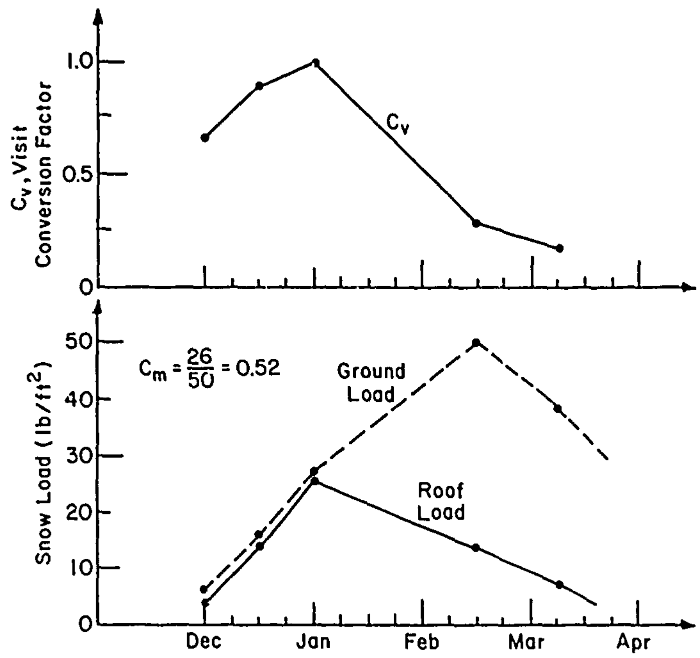


Figure 2. Variation of ground snow load, roof snow load and visit conversion factor with time (Structure No. 67, 1976–77).

structure for each visit, but there is only one C_m value per year. Because the maximum ground and roof loads often occur at different times, the recommendations contained in this report are based upon structures which were visited at least twice during a particular winter.

Ground load effects

The pattern of seasonal snowfall has an effect on the conversion factor for uniform loads. Areas with infrequent snowfalls and small accumulations have higher ground-to-roof conversion factors than colder areas with substantial ground snow accumulation. In a location where the winter is characterized by a few snowfalls separated by warmer weather, there will be little or no accumulation of ground snow from one snowfall to another. For this location both the maximum ground load and the maximum roof load occur immediately after the largest snowfall. Hence, the conversion factor would be relatively close to 1.

Now consider a location where the winter is characterized by a larger number of snowfalls closely spaced throughout the winter. Here the maximum ground load is due to accumulation throughout the winter. The maximum roof load is due to the same accumulation modified by wind, thermal and other effects. For this location the conversion factor for structures with similar characteristics would generally be less than for the first location. Differences in C_m for structures in the Albany, New York, area and in the Adirondack Mountains in northern New York have been attributed to differences in the patterns of seasonal snowfall at the two sites (O'Rourke 1978)

Since most building codes require a minimum roof live load between 12 and 20 lb/ft², the conversion factor should not be based on information associated with low ground loads. Therefore, snow load case studies for structures where the maximum annual ground load was less than 20 lb/ft² will not be considered.

Exposure effects

The effect of wind is the most important exposure parameter. Lutes (1970) reports the following ratios between roof and ground snow loads as a function of wind exposure: 0.9 for well-sheltered roofs, 0.6 for obstructed roofs, and 0.3 for well-exposed roofs.

Building codes have also recognized the effect of wind on roof snow loads. Both the 1977 Canadian National Building Code (National Research Council 1977) and the American National Standard (ANSI 1972) recommend a conversion factor of 0.8 for sheltered roofs. This value is reduced to 0.6 for roofs fully exposed to winds.

The roof and ground load data collected for this report (Appendix C) also illustrate the importance of wind. Figure 3 presents the mean and standard deviation of C_m for each exposure rating. The values in Figure 3 are for roofs with uniform loads on structures that were visited at least twice a year and that

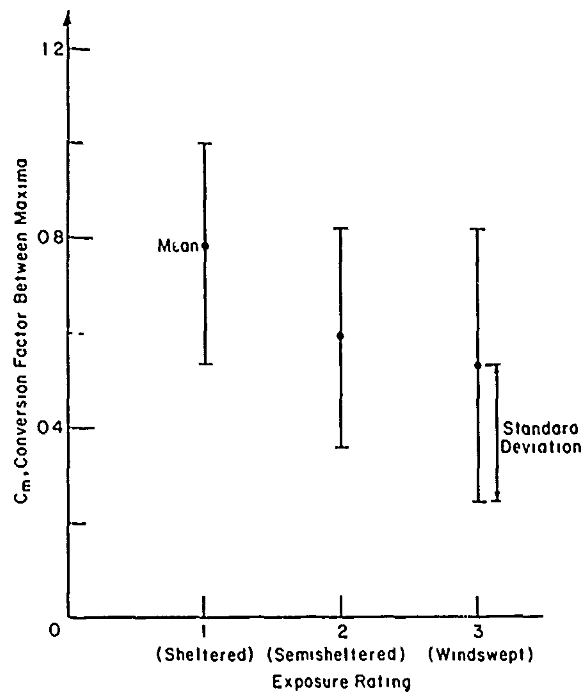


Figure 3. Conversion factor between maxima (C_m) vs exposure rating.

had a maximum ground load greater than 20 lb/ft^2. Of the 83 roofs in this category, 25 were sheltered, 23 were semisheltered and 35 were windswept. As expected, the conversion factors decrease as the wind exposure rating increases; the average values of C_m are 0.78 for the sheltered roofs, 0.59 for the semi-sheltered roofs, and 0.53 for the windswept roofs. As will be seen later, a structure's exposure has a stronger effect on its conversion factor than the other parameters.

Thermal effects

The ground-to-roof conversion factor should be a function of the roof's thermal characteristics. If a structure is heated, thermal energy flowing through the roof should melt the roof snow. On sloped roofs, snow sliding should be increased by the warming of the roof snow. This reduction in roof snow load would not take place for unheated structures.

The data in this report show that the conversion factor is indeed a function of whether the structure is heated or unheated. Figure 4 presents the means and standard deviations of C_m as a function of the thermal parameter H. The values in Figure 4 are drawn from the 77 roofs that were visited at least twice a year, that had maximum ground loads of at

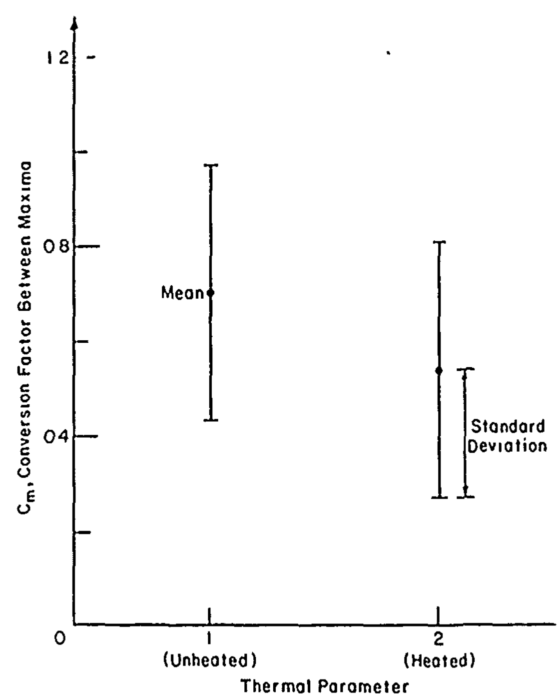


Figure 4. Conversion factor between maxima (C_m) vs thermal parameter.

least 20 lb/ft², and for which H is known. The average conversion factor for the unheated structures is about 0.70, while the corresponding value for heated structures is about 0.55. The standard deviations for both groups are relatively high. This is partly because the distributions of exposure ratings within the two groups are not the same.

Table 3 presents the conversion factor data subdivided by the thermal parameter and the exposure rating. For both heated and unheated structures C_m tends to decrease as the exposure rating increases. For each exposure rating C_m is lower for heated buildings.

Table 3. Average C_m for various combinations of thermal parameter and exposure.

	Exposure rating		
Heating parameter	*1 (Sheltered)*	*2 (Semisheltered)*	*3 (Windswept)*
1 (unheated)	0.84	0.66	0.55
	(17)*	(12)	(14)
2 (heated)	0.66	0.48	0.52
	(8)	(8)	(18)

*The numbers in parentheses indicate the number of roofs in each category.

A finer characterization of the thermal parameter, considering the thermal resistance (R-value) of the roof and roof venting, was also investigated. However, this did not yield consistent C_m values, probably due to the small number of roofs in each category and the tendency for wind effects to mask thermal effects. Data from a larger sample of roofs may yield more definitive results on the effect of roof venting and thermal resistance.

Slope effects

Roof slope should affect the ground-to-roof conversion factor; the larger the slope, the lower the conversion factor should be. However, the data in this report indicate that slope has little or no effect on C_m for roof slopes up to about 35°.

In Figure 5, the means and standard deviations of the conversion factors are plotted versus various ranges of roof slopes. The same 77 roofs that were considered in the thermal effects section are included. Of these roofs, 27 had roof slopes of less than 12°, 25 had slopes between 12° and 23°, 20 had slopes between 24° and 35° and 5 had slopes of 36° or greater. The data in Figure 5 indicate that C_m is unaffected by slopes less than 36°. However, the distribution of exposure ratings within the slope subgroups is not uniform. Since exposure has been shown to be important, a further subdivision similar to that used for thermal effects is appropriate.

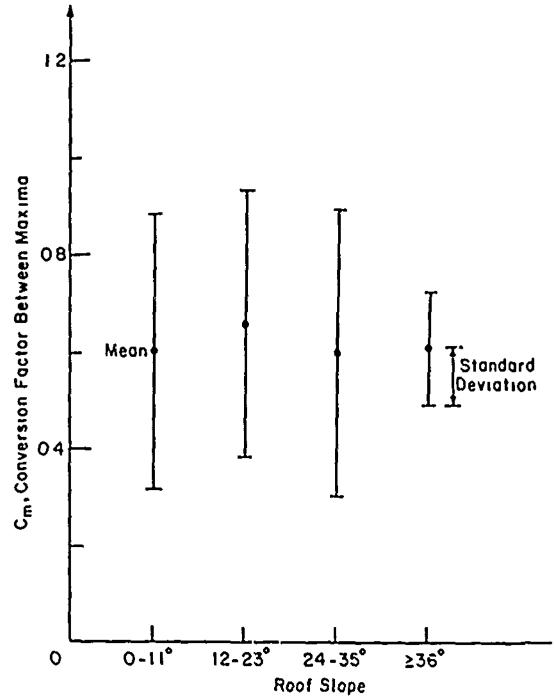


Figure 5. Conversion factor between maxima (C_m) vs roof slope.

Table 4 presents average C_m values for combinations of roof slope and exposure. There is a fairly consistent pattern associated with exposure; for each slope category the conversion factor tends to decrease with increasing exposure. There is, however, no trend associated with slope. Further subdivision by both exposure and thermal parameters also yields no discernible trends, mainly because most of the structures have relatively small slopes (less than 36°). For this

Table 4. Average C_m for various combinations of slope and exposure.

	Exposure rating		
Slope	*1 (Sheltered)*	*2 (Semisheltered)*	*3 (Windswept)*
0-11°	0.79	0.60	0.38
	(12)*	(6)	(10)
12-23°	0.66	0.62	0.71
	(5)	(8)	(12)
24-35°	0.83	0.47	0.44
	(8)	(5)	(7)
> 36°	-	0.73	0.55
	(0)	(2)	(3)

*The numbers in parentheses indicate the number of roofs in each category.

range of roof slopes, the effects on roof snow load are negligible, and most codes and standards do not allow a reduction in roof snow load for slopes less than about 30° (ANSI 1972, 1981, National Research Council 1977). The development of a relationship for structures with roof slopes of 36° and greater awaits more data; roof material (i.e. slippery or non-slippery) will likely be part of this relationship.

EXPECTED VALUE RELATIONSHIP

A new direction in the specification of design loads currently being adopted in the U.S. is the load and resistance factor design method. This method requires that the structural loads and structural resistances, or load-carrying capabilities, be expressed as an expected value (mean) and a variation about the expected value. Therefore, the relationship between the expected value $\bar{C}_m$ and the exposure and thermal parameters is developed in this section. Since roof slope has little effect on $\bar{C}_m$ for most of the structures studied, it is excluded from the expected value relationship. The variations of actual values about the mean or expected value are quantified by an error term ϵ.

The expected value relationship has the following form:

$$\bar{C}_m = \alpha \cdot E \cdot T \qquad (3)$$

where E is the exposure factor, T is the thermal factor and α is a constant. The exposure factor is a function of the average C_m values for each exposure rating. The semisheltered exposure will be used as the base (i.e. $E = 1.00$). The exposure factors for the other exposure groups are calculated by averaging the ratios of the average conversion factors between the group in question and the semisheltered group for both heating parameters in Table 3. This results in E values of 1.32 for sheltered roofs, 1.00 for semisheltered roofs and 0.95 for windswept roofs.

Notice that the ratio between the expected conversion factors for sheltered and windswept structures (1.32/0.95 = 1.39) is quite a bit smaller than that reported by Lutes (1970) (0.9/0.3 = 3.0). The 1982 A58.1 Standard (ANSI 1982) uses a value of 1.2/0.8 = 1.5 for this ratio.

The thermal factor T is a function of the C_m values for the heating parameter and was evaluated in a manner similar to that used for E. If heated structures are used as a base (i.e. $T = 1.00$), the thermal factor for unheated structures is calculated by averaging the ratio of the conversion factors between unheated and heated structures for all three exposure groups in Table 3. This results in T values of 1.22 for unheated structures and 1.00 for heated structures.

The variation of actual conversion factors about the expected values given by eq 3 is quantified by a multiplicative error term ϵ:

$$\epsilon = \frac{C_m}{\bar{C}_m} \qquad (4)$$

Since ϵ is always positive, a one-sided probability distribution should be used to model it. The log-normal probability distribution, which assumes that the natural log of ϵ has a normal distribution, was chosen for this purpose.

According to the usual probabilistic procedures (Benjamin and Cornell 1970), the constant α in the expected value relation should be chosen such that the mean of $\ln(\epsilon)$ equals zero, and hence the median of ϵ is one. For the 77 roofs used for the previous calculations, α was calculated to be 0.47. The expected value relationship becomes

$$\bar{C}_m = 0.47 \cdot E \cdot T \ . \qquad (5)$$

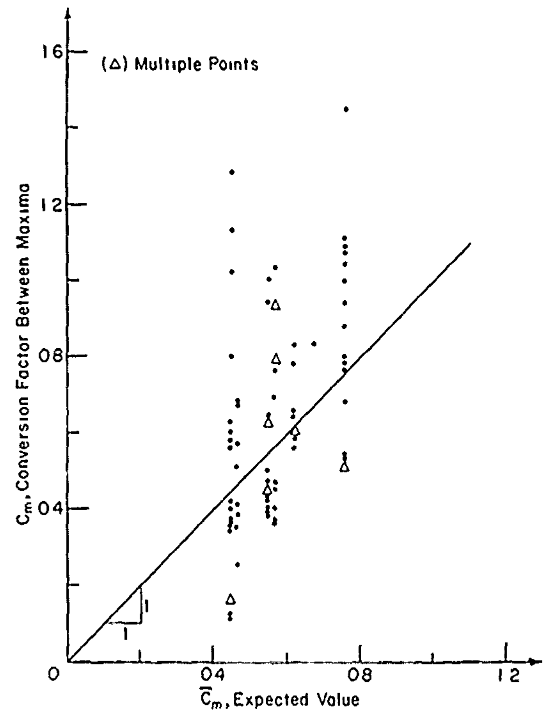


Figure 6. Conversion factors for uniform loads vs expected value from eq 5.

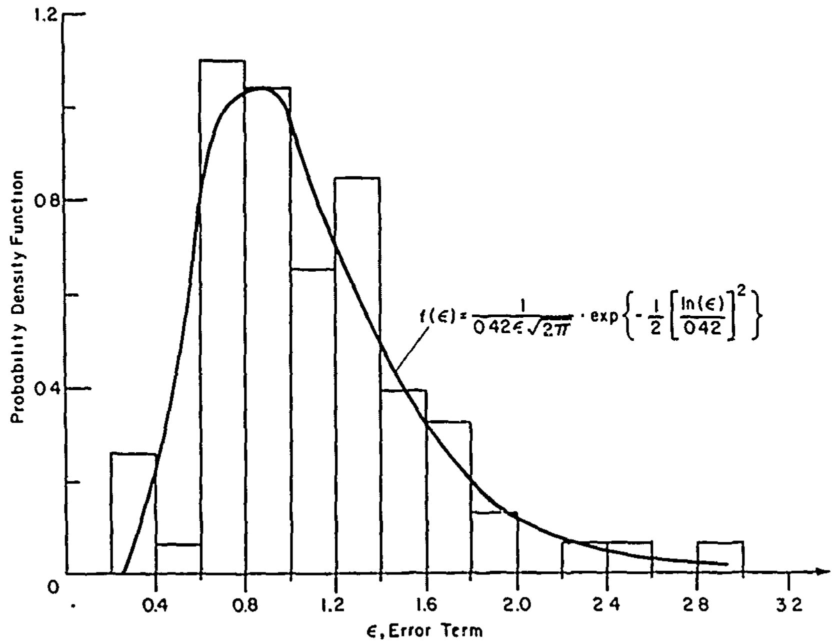


Figure 7. Histogram and probability density function for error term.

Figure 6 is a plot of the actual C_m values for the 77 roofs versus the $\overline{C}_m$ values calculated by using the appropriate values of E and T in eq 5. As anticipated, $\overline{C}_m$ captures the central tendency of the conversion factor data; that is, higher values for the actual data tend to be matched by higher values for $\overline{C}_m$.

Figure 7 is a histogram of the probability density of the error term ϵ. Fitting a log-normal distribution to the error term data results in a standard deviation for ln (ϵ) of 0.42. Hence the probability density function $f(\epsilon)$ becomes

$$f(\epsilon) = \frac{1}{0.42\,\epsilon\sqrt{2\pi}} \exp\left\{-\frac{1}{2}\left[\frac{\ln(\epsilon)}{0.42}\right]^2\right\} \quad (6)$$

The log-normal approximation for ϵ is also shown on Figure 7. Note that $f(\epsilon)$ matches the actual error term data well, particularly in the tail region ($\epsilon >$ 1.5), which is most important for load and resistance factor design.

Comparison with existing codes and standards

In this section, values of C_m from the case studies are compared with design guidance in existing building codes and standards. The 1977 National Building Code of Canada (National Research Council 1977) and the American National Standard A58.1-1972 (ANSI 1972) were chosen for this comparison. The snow load provisions of these two codes are similar in many respects. Since only uniform loads are considered in this report, the basic flat roof load modified for slope will be used.

In the Canadian code and the American standard the basic flat roof snow load p_f for structures with normal wind exposure is

$$p_f = 0.8\,p_g \quad (7)$$

where p_g is the design ground snow load. For structures fully exposed to wind,

$$p_f = 0.6\,p_g\,. \quad (8)$$

For these comparisons, structures rated sheltered or semisheltered are considered to have normal exposure, while structures rated windswept are considered to be fully exposed.

For roof slopes S greater than 30°, both documents allow a reduction in the design load:

$$p_r = \left[1 - 1.25\left(\frac{S - 30°}{50°}\right)\right]\,p_f \quad (9)$$

where p_r is the design load for sloped roofs.

Figure 8 is a plot of the case study conversion factors for the 77 structures versus the corresponding values recommended in the Canadian code and American standard. Notice that about 65% of the data

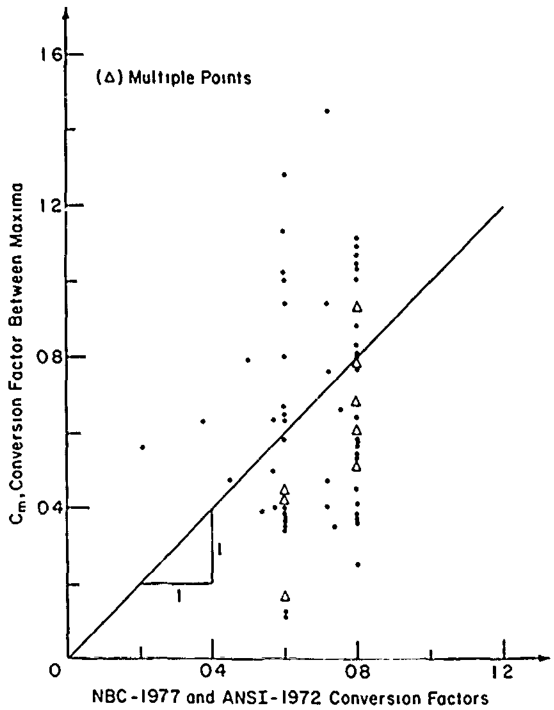


Figure 8. Conversion factors recommended in existing codes and standards vs case study values.

points fall below the 45° match line; that is, the uniform load provisions for both yield conservative estimates for the ratio between maximum roof load and maximum ground load.

Comparison with relationships proposed in new ANSI standard

In this section, values for the conversion factor C_m from the snow load case studies are compared with values in the 1982 ANSI A58.1 Load Standard. The 1982 ANSI provisions for uniform loads are based, in part, on a preliminary analysis of the data in this report.

The 1982 ANSI provisions for uniform loads are quite similar to those suggested by Tobiasson and Redfield (1973). They incorporate wind, thermal, slope and roofing material parameters in determining the uniform load conversion factor.

The 1982 ANSI equation for the basic flat roof snow load is

$$p_f = 0.70\, C_e \cdot C_t \cdot I \cdot p_g \tag{10}$$

where 0.70 is the reduction for normal roofs, C_e is the exposure factor, C_t is the thermal factor, I is the importance factor and p_g is the design ground snow load.

The exposure factor in the 1982 ANSI standard ranges from 0.8 to 1.2 for five classifications of roof exposure (Appendix D). Only three exposure classifications are used in this study, so the 1982 standards must be adjusted so they can be compared with the case study data. The 1982 ANSI values of C_e will be taken as 1.2 for sheltered roofs, 1.0 for semisheltered roofs, and 0.8 for windswept roofs. This adjustment eliminates category B (C_e = 0.9) and category D (C_e = 1.1). The 1982 ANSI exposure factors have about the same range as the wind exposure factors developed in this study.

The 1982 ANSI thermal factor C_t is a function of the inside temperature of the structure. As shown in Appendix D, C_t equals 1.0 for heated structures, 1.1 for structures kept just above freezing, and 1.2 for unheated structures. The thermal characteristics of the case study roofs are quantified by the heating parameter, which only considers heated and unheated structures. To allow a comparison, the 1982 ANSI C_t value for structures kept just above freezing was eliminated. Notice that the 1982 ANSI thermal factors are quite close to the thermal factor developed in this report.

The purpose of the risk factor I is to increase structural design loads for cases where the consequences of failure are greater than normal and to allow a reduction in load for structures where the consequences of failure are less than normal. The risk factors range from 0.8 to 1.2, with a value of 1.0 for most permanent structures. For the comparison of the 1982 ANSI standard with the snow load case studies, I = 1.0 will be used for all structures.

The 1982 ANSI design snow load for sloped roofs p_r is calculated from the flat roof design load p_f using the formula

$$p_r = C_s\, p_f \tag{11}$$

where C_s is the slope factor. The slope factor is a function of the roof material, roof slope and thermal factor C_t. Appendix D presents graphs of C_s versus roof slope for cold and warm roofs.

The 1982 ANSI conversion factor for uniform loads $(C_m)_A$ on normal risk structures in the contiguous United States is then the ratio of roof to ground load:

$$(C_m)_A = 0.70\, C_e\, C_t\, C_s\,. \tag{12}$$

Figure 9 is a plot of the conversion factors C_m from the case studies versus the corresponding 1982 ANSI values from eq 12. The trend of actual values

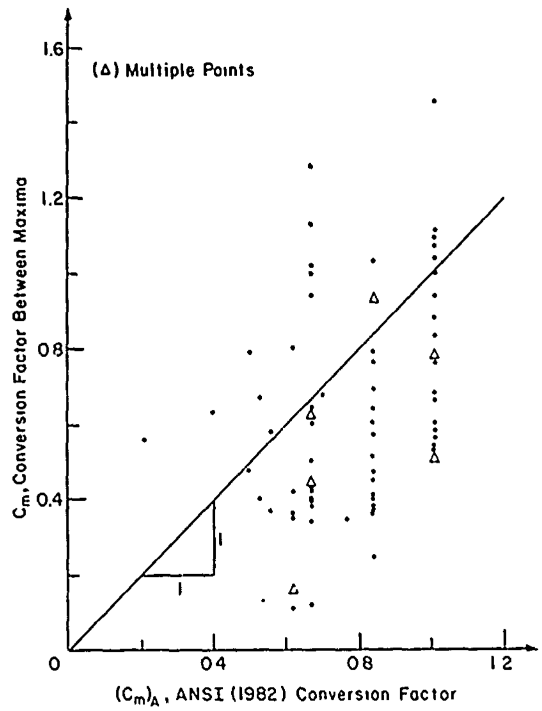


Figure 9. Conversion factors recommended in the 1982 ANSI Load Standard vs case study conversion factors.

matches the 1982 ANSI values reasonably well. About 25% of the points fall above the 45° matching line. This suggests that the proposed 1982 ANSI provisions for uniform snow loads are slightly more conservative than the Canadian and 1972 ANSI provisions.

SUMMARY AND CONCLUSIONS

In this report, information was analyzed on ground and roof snow loads extracted from a data base for 199 structures gathered over a three-year period. A conversion factor for uniform loads, defined as the maximum uniform roof load for a structure during a particular winter divided by the maximum ground load that winter, was calculated for each structure. Relationships between the ground-to-roof conversion factors and parameters such as roof slope, exposure and thermal characteristics were investigated. The measured conversion factors were compared with those recommended in the 1977 National Building Code of Canada, the 1972 American National Standard, and the 1982 ANSI Load Standard.

The conversion factor was most strongly influenced by the exposure of the structure: the greater the exposure, the smaller the conversion factor. The conversion factor was influenced to a lesser degree by the thermal characteristics of the structure, that is, whether it is heated or unheated. For the structures in this study, roof slopes between 0° and 35° did not have an observable effect on the conversion factor.

An expected value relationship between the structure's exposure and thermal parameters and the conversion factor was established. The variation of observed values about the expected or mean value was quantified by an error term ϵ, defined as the ratio of observed to expected values. A log-normal distribution with a mean of $\ln(\epsilon) = 0.00$ and a standard deviation of $\ln(\epsilon) = 0.42$ was shown to be a good model for the error term.

Finally, recommendations for uniform roof snow load found in the 1977 National Building Code of Canada, the 1972 American National Standard, and the 1982 American National Standard were compared with values from the case studies. The uniform load provisions in all three standards yield estimates for the ratio between maximum roof load and maximum ground load which are, on the average, larger than measured values.

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APPENDIX A. ROOF SNOW LOAD CASE HISTORY REPORTS.

These are available for examination at CRREL.

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APPENDIX B. ROOFS IN THE SNOW LOAD CASE STUDY DATA BASE.

Structure number	*Roof number*	*Slope (degrees)*	*Heating* parameter*	*Exposure* rating*	*Roof * geometry*	*Structure number*	*Roof number*	*Slope (degrees)*	*Heating parameter*	*Exposure rating*	*Roof geometry*
3	1	0	1	2	3	61	1	12	2	3	1
9	1	6	2	3	3	62	1	18	2	3	1
10	1	0	2	3	3	63	1	12	2	3	1
11	1	0	2	3	3	64	1	12	2	1	1
13	1	0	2	3	3	65	1	28	2	1	1
14	1	0	2	3	3	66	1	17	2	1	1
15	1	0	2	3	3	67	1	32	2	1	1
16	1	0	2	3	3	68	1	22	2	1	1
18	1	0	2	3	3	69	1	0	1	1	1
19	1	0	2	3	3	70	1	38	2	2	1
25	1	33	2	2	1	71	1	19	2	3	1
26	1	14	1	2	1	72	1	19	2	2	1
26	2	28	1	2	1	73	1	23	1	3	1
27	1	34	1	2	1	74	1	18	0	3	1
27	2	14	1	2	3	75	1	18	0	3	1
28	1	34	1	2	1	76	1	18	0	2	1
28	2	9	1	2	1	77	1	17	2	2	1
29	1	27	2	3	1	78	1	14	2	3	1
29	2	7	2	3	1	79	1	24	2	2	1
30	1	27	2	3	1	80	1	21	2	2	1
30	2	5	2	3	3	81	1	22	2	3	1
31	1	28	1	2	1	82	1	20	2	3	1
32	1	35	2	2	1	83	1	0	2	3	1
32	2	7	2	2	1	84	1	12	2	3	1
33	1	16	1	2	1	85	1	20	2	2	1
34	1	27	2	3	1	86	1	20	2	3	1
34	2	27	2	3	1	87	1	20	2	3	1
35	1	25	2	3	1	88	1	13	2	3	1
35	2	16	1	3	1	89	1	10	2	2	1
36	1	25	2	3	1	90	1	28	2	1	1
37	1	35	2	3	1	91	1	23	1	1	1
38	1	23	2	3	1	93	1	0	2	2	2
39	1	37	2	2	1	94	1	0	2	2	1
39	2	37	2	2	1	95	1	56	2	3	1
40	1	0	2	3	1	96	1	18	2	3	1
40	2	0	2	3	1	97	1	45	1	2	1
41	1	0	2	3	1	98	1	27	1	3	1
42	1	0	2	3	1	99	1	0	2	3	1
43	1	0	2	3	1	100	1	45	1	3	1
44	1	0	2	3	1	101	1	45	1	3	1
45	1	5	1	3	1	102	1	2	2	3	1
46	1	18	1	3	2	103	1	5	2	1	1
47	1	18	1	3	1	104	1	7	1	1	1
48	1	0	2	3	1	105	1	34	2	2	1
49	1	10	2	3	1	106	1	0	2	2	1
50	1	30	2	3	1	107	1	2	2	2	1
50	2	7	1	3	3	108	1	0	2	3	2
51	1	14	2	3	1	109	1	0	2	3	2
52	1	0	2	2	1	110	1	0	2	2	2
53	1	0	2	2	1	111	1	0	2	3	2
54	1	27	2	3	1	111	2	0	2	3	2
55	1	27	2	3	1	112	1	0	2	3	2
56	1	15	2	3	1	112	2	0	2	3	3
57	1	12	2	3	1	112	3	0	2	3	3
58	1	12	2	3	1	113	1	0	2	3	2
59	1	12	2	3	1	113	2	0	2	3	2
60	1	27	2	3	1	114	1	0	2	3	2

*Heating parameter (1: unheated; 2: heated).
Exposure rating (1: sheltered; 2: semisheltered; 3: windswept).
Roof geometry (1: uniform loads; 2: parapet drifting; 3: multilevel roof drifting).

Structure number	Roof number	Slope (degrees)	Heating parameter	Exposure rating	Roof geometry
115	1	0	2	2	2
115	2	0	2	2	2
116	1	0	2	3	2
117	1	0	2	3	2
118	1	23	2	3	1
118	2	23	2	3	1
119	1	23	2	3	1
119	2	23	2	3	1
120	1	0	2	3	1
121	1	40	1	2	1
122	1	0	2	3	2
123	1	0	2	3	2
124	1	0	2	3	1
125	1	0	2	3	1
126	1	0	2	3	1
127	1	0	2	3	1
128	1	0	2	2	1
129	1	0	2	3	2
130	1	6	2	3	1
130	2	6	1	3	1
131	1	0	2	3	1
132	1	18	2	3	1
133	1	0	2	3	1
134	1	0	2	3	2
135	1	0	2	3	1
136	1	0	2	2	2
136	2	0	2	2	3
136	3	0	2	2	2
137	1	3	2	3	1
138	1	45	2	2	1
139	1	0	2	3	2
140	1	0	2	3	2
140	2	0	2	3	2
140	3	0	2	3	1
141	1	28	2	2	1
141	2	26	2	2	1
142	1	16	2	2	1
142	2	24	2	2	1
142	3	4	2	2	1
143	1	24	2	2	1
143	2	20	1	2	3
144	1	27	2	2	1
144	2	25	2	2	3
145	1	11	2	3	1
145	2	0	1	3	3
146	1	35	2	2	1
146	2	0	2	2	3
146	3	17	2	2	1
147	1	27	2	3	3
147	2	9	2	3	1
148	1	0	1	2	3
149	1	5	2	2	2
149	2	0	2	2	1
149	3	0	2	2	3
150	1	0	2	2	3
150	2	0	2	2	1
150	3	8	2	2	1
151	1	0	2	3	2
152	1	0	2	3	2
153	1	0	2	3	2
153	2	0	2	3	2
154	1	0	2	3	1
155	1	0	2	3	2
156	1	0	2	2	3
156	2	60	2	2	1
157	1	0	2	3	2
158	1	0	2	3	2
159	1	0	2	3	2
160	1	0	2	3	3
160	2	0	2	3	1
161	1	0	2	3	2
162	1	0	2	3	3
162	2	0	2	3	1
162	3	0	2	3	3
163	1	0	2	3	2
165	1	30	2	1	1
166	1	27	2	2	1
167	1	25	2	2	1
168	1	22	2	2	1
169	1	21	2	2	1
170	1	25	2	2	1
171	1	18	1	2	1
171	2	21	1	2	1
172	1	11	1	1	1
173	1	5	1	1	1
174	1	5	1	2	1
175	1	0	1	2	1
176	1	34	1	1	1
177	1	0	1	1	3
177	2	5	1	1	1
178	1	0	2	2	1
179	1	0	1	2	2
180	1	27	2	2	1
181	1	28	1	2	1
182	1	18	2	3	1
183	1	23	2	3	1
184	1	13	1	3	1
184	2	3	1	3	1
185	1	32	1	3	1
186	1	32	1	3	1
187	1	37	1	3	1
187	2	24	1	3	3
187	3	28	1	3	3
188	1	0	1	3	1
189	1	32	2	1	1
190	1	14	1	1	1
190	2	23	1	1	1
190	3	7	1	1	1
191	1	0	2	2	2
192	1	32	2	3	1
193	1	10	1	3	1
194	1	32	1	3	1
195	1	17	2	3	1
196	1	25	2	3	1
196	2	25	2	3	1
196	3	25	2	3	1
196	4	25	2	3	1
97	1	23	1	1	1
198	1	16	1	1	1
99	1	13	2	3	1
00	1	25	1	1	1
200	2	10	1	1	2
201	1	5	1	1	1
201	2	28	1	1	1

Structure number	Roof number	Slope (degrees)	Heating parameter	Exposure rating	Roof geometry
201	3	0	1	1	1
202	1	40	1	2	1
203	1	4	1	2	1
204	1	0	1	2	1
205	1	40	1	3	1
206	1	9	1	3	1
207	1	27	1	3	1
208	1	10	1	3	1
209	1	34	1	3	1
209	2	10	1	3	1
210	1	25	1	2	1
211	1	34	1	1	1
212	1	40	2	2	1
213	1	25	0	3	1
214	1	0	2	3	2

APPENDIX C: GROUND AND ROOF SNOW LOAD DATA

APPENDIX C. GROUND AND ROOF SNOW LOAD DATA.

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
3	1	12/ 8/77	9.5	3.7	17.7	4.4
3	1	12/27/77	17.0	6.2	19.4	6.9
3	1	1/ 6/78	10.7	15.6	13.2	13.1
3	1	1/16/78	6.5	10.6	9.4	21.8
3	1	1/23/78	21.5	13.7	-1*	10.0
3	1	1/30/78	24.0	10.0	21.4	11.9
3	1	2/ 7/78	25.0	10.0	25.3	12.8
3	1	2/15/78	21.1	13.1	-1	-1
3	1	2/28/78	21.0	15.6	34.0	16.8
3	1	3/15/78	10.0	23.1	12.2	20.0
9	1	12/27/77	6.0	4.4	5.3	5.3
9	1	1/12/78	0.0	0.0	5.8	19.3
9	1	1/23/78	10.0	8.1	5.1	15.0
9	1	1/30/78	8.0	6.9	4.0	11.5
9	1	2/ 7/78	13.0	10.6	6.2	17.4
9	1	2/15/78	5.9	8.1	-1	-1
9	1	3/ 2/78	12.0	11.2	5.0	16.8
9	1	3/15/78	0.0	0.0	2.3	20.9
10	1	12/27/77	8.0	6.9	25.3	8.7
10	1	1/12/78	5.0	13.7	2.5	17.2
10	1	1/23/78	12.0	10.6	7.8	16.2
10	1	1/30/78	9.5	10.0	9.3	13.4
10	1	2/ 8/78	13.0	10.0	9.2	15.9
10	1	2/15/78	11.8	16.2	-1	-1
10	1	3/ 2/78	16.6	13.7	11.1	19.7
10	1	3/15/78	6.0	30.0	4.5	26.2
11	1	12/27/77	8.5	6.2	5.2	10.6
11	1	1/12/78	0.5	28.1	3.5	24.0
11	1	1/23/78	9.0	10.6	4.9	12.8
11	1	1/31/78	3.0	16.8	5.4	9.4
11	1	2/ 8/78	8.0	7.5	6.6	15.3
11	1	2/15/78	6.0	18.1	-1	-1
11	1	3/ 2/78	29.0	10.6	6.0	18.4
11	1	3/15/78	0.0	0.0	1.2	23.1
13	1	12/29/77	4.9	5.6	2.6	11.2
13	1	1/12/78	0.0	0.0	1.2	20.3
13	1	1/24/78	6.5	6.2	3.6	19.7
13	1	1/31/78	4.6	3.1	2.3	11.9
13	1	2/ 8/78	9.0	11.2	2.8	18.7
13	1	2/15/78	7.5	14.4	-1	-1
13	1	3/ 2/78	9.5	18.7	2.2	17.5
13	1	3/15/78	0.0	0.0	0.7	27.8
14	1	12/27/77	12.0	2.5	4.5	6.2
14	1	1/12/78	0.0	0.0	6.0	14.4
14	1	1/24/78	8.0	8.7	4.0	19.7
14	1	1/30/78	3.2	-1	5.8	8.1
14	1	2/ 8/78	8.5	10.6	7.2	14.0
14	1	2/15/78	4.9	21.8	-1	-1
14	1	3/ 3/78	8.0	13.1	5.5	21.2
14	1	3/15/78	0.0	0.0	1.0	33.4
15	1	12/28/77	17.0	3.1	-1	-1
15	1	1/12/78	0.0	0.0	0.0	0.0
15	1	1/24/78	11.5	13.1	1.5	12.5
15	1	1/31/78	7.6	22.5	2.5	12.5
15	1	2/ 8/78	10.6	6.2	2.3	17.8
15	1	2/15/78	8.1	11.9	-1	-1
15	1	3/ 2/78	11.0	11.9	1.9	19.7
16	1	12/12/77	8.0	13.7	1.3	20.0
16	1	12/30/77	3.0	9.4	1.1	15.9
16	1	1/13/78	11.0	37.4	2.0	14.0
16	1	1/19/78	6.0	11.9	2.7	13.1
16	1	2/ 2/78	6.0	15.0	1.9	7.5
16	1	2/ 9/78	8.5	13.7	2.9	19.3
16	1	2/15/78	4.3	22.5	-1	-1
16	1	3/ 3/78	11.0	11.9	1.4	20.0
18	1	12/28/77	11.5	5.0	4.2	17.2
18	1	1/12/78	1.3	30.0	0.3	22.8
18	1	1/19/78	5.0	19.3	1.2	9.4
18	1	2/ 2/78	2.5	20.0	1.2	8.4
18	1	2/ 9/78	6.0	10.6	4.3	20.3
18	1	2/15/78	11.0	17.5	-1	-1
18	1	3/ 3/78	11.0	23.1	2.5	25.3
19	1	12/28/77	13.6	6.2	5.6	7.8
19	1	1/12/78	0.0	0.0	4.9	21.5
19	1	1/19/78	8.0	17.5	4.8	20.0
19	1	2/ 3/78	6.0	14.4	4.7	12.2
19	1	2/ 9/78	10.0	11.2	9.3	20.6
19	1	2/15/78	9.0	18.7	-1	-1
19	1	3/ 3/78	8.5	15.6	10.1	19.7
19	1	3/15/78	0.0	0.0	1.9	27.8
25	1	1/11/78	16.0	21.2	10.0	16.1
25	1	1/20/78	20.0	17.5	4.0	10.6
25	1	2/20/78	24.0	18.6	7.0	16.4
25	1	3/ 7/78	31.0	17.7	3.0	13.1
25	1	5/ 9/78	20.0	11.4	18.0	10.7
26	1	1/11/78	16.0	21.2	4.0	-1
26	2	1/11/78	16.0	21.2	4.0	-1
26	1	1/20/78	20.0	17.5	5.0	14.1
26	2	1/20/78	20.0	17.5	7.0	14.1
26	1	2/20/78	24.0	18.6	6.0	17.5
26	2	2/20/78	24.0	18.6	5.0	17.5
26	1	3/ 7/78	31.0	17.7	4.0	14.3
26	2	3/ 7/78	31.0	17.7	2.0	14.3

*Indicates unknown information.

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Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
26	1	5/ 9/78	18.5	9.3	22.0	9.8
26	2	5/ 9/78	18.5	9.3	20.0	9.8
27	1	1/11/78	16.0	21.2	8.0	15.4
27	2	1/11/78	16.0	21.2	10.0	15.4
27	1	1/20/78	20.0	17.5	7.0	10.8
27	2	1/20/78	20.0	17.5	9.0	10.8
27	1	2/20/78	24.0	18.6	7.0	16.2
27	2	2/20/78	24.0	18.6	10.0	16.2
27	1	3/ 7/78	31.0	17.7	10.0	26.2
27	2	3/ 7/78	31.0	17.7	17.0	26.2
27	1	5/ 9/78	18.0	10.3	25.0	10.4
27	2	5/ 9/78	18.0	10.3	27.0	10.4
28	1	1/11/78	16.0	21.2	4.0	-1
28	2	1/11/78	16.0	21.2	0.5	-1
28	1	1/20/78	20.0	17.5	7.0	-1
28	2	1/20/78	20.0	17.5	4.0	-1
28	1	2/20/78	24.0	18.6	4.0	-1
28	2	2/20/78	24.0	18.6	2.0	-1
28	1	3/ 7/78	31.0	17.7	3.0	8.7
28	2	3/ 7/78	31.0	17.7	3.0	8.7
28	1	5/ 9/78	18.0	10.3	22.0	9.9
28	2	5/ 9/78	18.0	10.3	25.0	9.9
29	1	5/ 9/78	18.0	9.5	14.0	11.3
29	2	5/ 9/78	18.0	9.5	15.0	11.3
30	1	5/ 9/78	12.0	11.6	13.0	12.8
30	2	5/ 9/78	12.0	11.6	11.0	12.8
31	1	5/10/78	9.0	11.6	16.0	11.4
32	1	5/10/78	11.0	10.3	9.8	12.5
32	2	5/10/78	11.0	10.3	13.0	12.5
33	1	5/10/78	9.5	13.8	12.5	11.8
34	1	5/10/78	11.5	11.0	8.5	11.3
34	2	5/10/78	11.5	11.0	8.0	11.3
35	1	3/ 6/78	9.0	22.9	1.0	18.2
35	2	3/ 6/78	9.0	22.9	1.0	23.4
35	1	5/10/78	9.0	18.0	7.0	12.9
35	2	5/10/78	9.0	18.0	13.0	16.1
36	1	5/10/78	6.0	17.4	0.0	0.0
37	1	5/10/78	6.0	17.4	7.5	14.3
38	1	5/10/78	10.0	16.7	11.0	15.2
39	1	5/10/78	10.0	13.9	11.5	11.9
39	2	5/10/78	10.0	13.9	8.0	11.9
40	1	3/ 3/78	4.5	8.0	3.5	6.8
40	2	3/ 3/78	4.5	8.0	3.0	6.8
40	1	4/11/78	3.5	16.0	1.5	4.1
40	1	5/ 8/78	9.0	17.8	6.5	25.9
40	2	5/ 8/78	9.0	17.8	7.5	23.4
41	1	5/ 8/78	9.0	17.8	6.5	24.4
42	1	3/ 5/78	3.0	10.2	1.0	9.7

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
42	1	4/11/78	2.5	15.2	1.5	15.8
42	1	5/ 8/78	5.5	22.4	7.3	28.4
43	1	3/ 5/78	3.0	9.9	2.0	10.7
43	1	5/ 7/78	11.0	15.9	10.5	17.2
44	1	5/ 7/78	11.0	15.9	13.5	19.0
45	1	5/ 7/78	11.5	14.1	11.0	14.1
46	1	5/ 7/78	10.5	15.4	13.0	13.5
47	1	5/ 7/78	8.5	13.2	14.0	17.9
48	1	5/ 8/78	11.0	13.5	4.5	29.1
49	1	5/ 7/78	12.0	17.4	9.0	14.2
50	1	5/ 7/78	12.0	17.4	13.5	14.4
50	2	5/ 7/78	12.0	17.4	14.0	16.2
51	1	5/ 7/78	12.0	17.4	14.0	16.5
52	1	5/ 7/78	9.5	18.3	9.0	20.1
53	1	5/ 7/78	10.0	15.5	8.0	22.2
54	1	5/ 7/78	6.0	22.6	7.5	20.8
55	1	5/ 7/78	6.0	22.6	5.0	22.3
56	1	12/ 7/76	13.5	13.7	5.0	9.4
56	1	12/21/76	13.0	19.3	5.0	13.7
56	1	1/18/77	25.0	17.5	5.0	7.5
56	1	2/15/77	20.0	20.9	6.0	22.5
56	1	3/10/77	22.0	20.0	1.0	25.6
57	1	12/14/76	11.3	14.4	0.0	0.0
57	1	12/21/76	17.0	14.4	1.0	8.7
57	1	1/18/77	20.0	15.0	1.5	20.6
57	1	2/17/77	20.0	25.6	0.0	0.0
57	1	3/10/77	16.0	23.4	0.0	0.0
58	1	12/ 4/76	8.0	12.5	3.0	12.5
58	1	12/16/76	11.5	18.7	0.0	0.0
58	1	1/ 4/77	19.7	18.7	0.0	0.0
58	1	2/15/77	11.0	13.1	0.0	0.0
58	1	3/10/77	14.0	24.3	0.0	0.0
59	1	12/14/76	12.0	18.1	0.0	0.0
59	1	12/21/76	11.5	18.7	3.0	16.8
59	1	1/18/77	20.7	20.6	3.0	16.8
59	1	2/17/77	28.0	20.0	1.5	18.1
59	1	3/10/77	16.3	16.[illegible]	0.0	0.0
60	1	12/ 7/76	15.5	15.0	3.0	7.5
60	1	12/21/76	11.3	1[illegible].5	3.0	7.5
60	1	1/18/77	27.5	1[illegible].2	4.0	13.7
60	1	2/15/77	15.0	22.5	3.0	13.1
60	1	3/10/77	22.0	20.0	0.0	0.0
61	1	12/14/76	12.0	20.6	5.0	17.5
61	1	12/21/76	17.0	16.2	5.0	16.2
61	1	1/18/77	22.0	14.0	5.0	21.2
61	1	3/10/77	21.3	21.8	0.0	0.0
62	1	12/14/76	13.0	19.3	12.0	14.4
62	1	1/ 4/77	19.5	12.8	17.0	20.0

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
62	1	1/20/77	17.0	17.5	17.0	14.0
62	1	2/17/77	19.0	21.8	10.0	21.8
62	1	3/10/77	25.0	26.8	8.0	26.2
63	1	12/ 7/76	14.0	15.6	2.0	11.2
63	1	12/21/76	12.0	20.6	2.0	11.2
63	1	1/18/77	22.5	15.6	4.0	13.7
63	1	3/10/77	15.0	17.5	0.0	0.0
64	1	12/14/76	13.0	19.3	12.0	14.0
64	1	1/ 4/77	22.0	13.1	18.5	13.1
64	1	2/17/77	20.0	18.7	15.0	20.6
65	1	12/ 4/76	12.0	13.1	14.0	11.5
65	1	12/16/76	12.0	20.6	10.0	17.8
65	1	1/ 4/77	20.0	15.6	15.0	16.8
65	1	3/10/77	29.0	20.6	10.0	22.5
66	1	12/ 4/76	12.0	8.7	12.8	8.7
66	1	12/16/76	14.0	18.1	10.0	18.7
66	1	1/ 6/77	19.5	22.5	14.0	18.1
66	1	2/15/77	25.0	18.7	14.0	20.0
66	1	3/10/77	24.0	18.1	9.0	23.7
67	1	12/ 4/76	10.0	7.5	6.5	7.5
67	1	12/16/76	9.5	20.0	10.0	16.8
67	1	1/ 4/77	19.3	16.8	19.0	16.8
67	1	2/15/77	27.5	21.8	7.0	23.1
67	1	3/10/77	20.0	23.1	3.0	22.5
68	1	12/16/76	12.0	20.6	10.0	16.8
68	1	1/ 6/77	19.8	21.2	17.0	16.2
68	1	1/20/77	24.5	18.1	21.0	16.2
68	1	2/15/77	31.5	18.7	12.5	16.8
68	1	3/10/77	24.0	18.1	12.0	23.7
69	1	1/16/77	21.0	15.0	21.0	15.0
69	1	2/12/77	19.0	16.2	19.0	16.2
69	1	2/25/77	20.0	15.6	19.0	18.1
70	1	12/ 7/76	12.0	13.1	10.0	11.9
70	1	1/ 6/77	17.5	12.5	16.0	15.0
70	1	1/20/77	28.0	15.6	21.0	15.0
70	1	2/15/77	25.5	15.9	14.0	21.2
71	1	12/ 4/76	13.0	11.9	10.0	9.4
71	1	12/16/76	11.0	22.5	5.0	14.4
71	1	1/20/77	26.0	16.8	8.5	17.5
71	1	2/17/77	29.0	22.5	11.0	20.6
72	1	12/14/76	9.5	13.1	11.5	10.3
72	1	12/16/76	10.0	15.6	9.0	18.7
72	1	1/ 6/77	26.0	20.9	11.5	18.1
72	1	3/10/77	30.0	20.6	0.0	0.0
73	1	12/ 7/76	17.0	16.2	16.5	18.1
73	1	1/20/77	35.0	18.1	31.0	19.3
73	1	12/18/76	11.0	21.2	11.1	24.3

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
73	1	2/16/77	29.0	22.0	19.8	24.6
212	1	12/ 7/76	14.5	13.1	10.0	10.3
212	1	1/ 6/77	19.3	16.8	8.0	17.2
212	1	1/20/77	26.0	16.8	5.0	11.2
212	1	2/15/77	31.0	22.2	2.0	22.2
213	1	12/ 7/76	14.0	13.1	10.0	15.9
213	1	1/ 4/77	19.5	15.9	14.0	28.1
213	1	1/20/77	26.0	16.8	14.0	24.2
213	1	2/15/77	26.0	20.0	6.0	21.2
74	1	1/14/78	18.0	13.9	8.5	11.0
74	1	1/28/78	15.0	16.6	1.0	-1
74	1	2/11/78	19.5	19.2	2.0	-1
74	1	2/22/78	21.0	17.8	3.0	-1
74	1	3/11/78	26.0	14.4	4.0	-1
75	1	1/ 7/78	18.0	13.9	7.0	11.2
75	1	1/14/78	18.0	13.9	7.0	8.9
75	1	1/28/78	15.0	16.6	1.0	-1
75	1	2/11/78	19.5	19.2	1.5	-1
75	1	2/22/78	21.0	17.8	1.5	-1
75	1	3/11/78	26.0	14.4	4.0	-1
76	1	1/ 7/78	17.0	11.0	7.5	11.2
76	1	1/14/78	23.0	14.9	7.0	8.9
76	1	1/28/78	19.0	18.1	2.0	-1
76	1	2/11/78	20.0	15.6	2.0	-1
76	1	2/22/78	33.0	20.8	2.0	-1
76	1	3/11/78	26.0	14.4	1.0	-1
77	1	1/ 7/78	17.0	11.0	8.0	21.3
77	1	1/14/78	23.0	14.9	9.0	10.4
77	1	1/28/78	19.0	18.1	8.0	11.7
77	1	2/11/78	20.0	15.6	8.0	11.7
77	1	2/22/78	33.0	20.8	8.0	11.7
77	1	3/11/78	26.0	14.4	4.0	-1
77	1	3/18/78	24.0	18.2	11.0	11.3
78	1	1/ 7/78	14.0	25.6	15.5	28.7
78	1	1/14/78	14.5	12.9	13.0	9.6
78	1	1/28/78	19.0	14.8	13.0	12.0
78	1	2/11/78	21.0	16.3	16.0	15.6
78	1	2/22/78	22.5	19.4	14.0	15.6
78	1	3/11/78	20.0	18.7	11.0	19.9
78	1	3/18/78	22.0	17.0	18.0	17.3
79	1	1/ 7/78	14.0	25.6	9.5	-1
79	1	1/14/78	14.5	12.9	9.0	10.4
79	1	1/28/78	19.0	14.8	2.0	-1
79	1	2/11/78	21.0	16.3	9.0	10.4
79	1	2/22/78	22.5	19.4	11.0	11.3
79	1	3/11/78	20.0	18.7	10.0	15.6
79	1	3/18/78	22.0	17.0	15.0	14.6
80	1	1/ 7/78	15.0	33.1	12.0	25.0

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
80	1	1/14/78	16.5	15.1	12.0	13.0
80	1	1/28/78	17.0	18.4	10.0	12.5
80	1	2/11/78	28.0	18.9	14.0	13.4
80	1	2/22/78	20.0	18.7	13.5	16.2
80	1	3/11/78	23.0	13.6	18.0	24.0
80	1	3/18/78	31.0	17.1	11.0	19.9
81	1	1/ 7/78	17.0	11.0	10.5	-1
81	1	1/14/78	17.0	14.7	5.5	17.0
81	1	1/28/78	16.0	15.6	9.0	13.9
81	1	2/11/78	17.0	18.4	10.0	18.7
81	1	2/22/78	21.0	20.8	2.5	-1
81	1	3/11/78	20.0	18.7	3.0	-1
81	1	3/18/78	20.0	14.0	9.0	17.3
62	1	1/ 7/78	16.0	-1	6.5	-1
62	1	1/14/78	17.0	12.8	8.0	11.7
62	1	1/28/78	18.0	15.6	5.0	12.5
62	1	2/11/78	17.0	18.4	8.0	19.5
62	1	2/22/78	17.0	22.0	12.5	17.5
62	1	3/11/78	16.0	27.3	9.5	23.0
62	1	3/18/78	19.0	14.8	11.0	14.2
82	1	1/ 7/78	15.0	12.5	6.0	-1
82	1	1/14/78	17.5	16.0	5.0	12.5
82	1	1/28/78	17.0	18.4	4.0	7.8
82	1	2/11/78	18.0	20.8	1.5	-1
82	1	2/22/78	19.0	16.4	13.0	24.0
82	1	3/11/78	16.0	23.4	3.0	-1
83	1	1/ 7/78	18.0	10.4	8.0	33.7
83	1	1/14/78	18.0	13.9	1.0	-1
83	1	1/28/78	17.0	18.4	0.0	0.0
83	1	2/11/78	18.0	20.8	2.0	-1
83	1	2/22/78	19.0	18.1	0.0	0.0
83	1	3/11/78	17.0	14.7	-1	-1
84	1	1/ 7/78	13.0	12.0	5.0	27.8
84	1	1/14/78	14.5	12.9	1.0	-1
84	1	1/28/78	15.5	16.2	2.0	-1
84	1	2/11/78	18.0	19.1	2.5	-1
84	1	2/22/78	17.0	18.4	4.0	-1
84	1	3/11/78	27.0	20.9	4.0	-1
85	1	1/ 7/78	13.0	12.0	2.5	27.7
85	1	1/14/78	14.5	12.9	1.0	-1
85	1	1/28/78	15.5	16.2	4.0	-1
85	1	2/11/78	18.0	19.1	2.5	-1
85	1	2/22/78	17.0	18.4	2.0	-1
85	1	3/11/78	27.0	20.9	4.5	-1
86	1	1/ 7/78	13.0	12.0	7.0	-1
86	1	1/14/78	14.5	12.9	2.0	-1
86	1	1/28/78	15.5	16.2	23.0	-1
86	1	2/11/78	18.0	19.1	8.0	-1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
86	1	2/22/78	17.0	18.4	4.0	-1
86	1	3/11/78	27.0	20.8	6.0	13.0
87	1	1/30/78	21.0	13.4	9.0	10.4
87	1	2/13/78	20.0	14.0	11.0	11.3
87	1	2/22/78	21.5	16.0	11.0	11.3
88	1	1/28/78	22.0	14.2	13.0	12.0
88	1	2/11/78	17.0	18.4	18.0	17.3
88	1	2/22/78	23.0	17.6	15.0	14.6
88	1	3/18/78	20.0	21.8	10.5	20.8
73	1	1/22/78	24.0	20.8	16.5	15.1
73	1	2/ 7/78	37.0	18.6	17.3	14.5
73	1	2/18/78	36.0	13.9	21.0	11.9
73	1	3/12/78	32.0	29.5	14.5	21.5
73	1	3/23/78	36.0	20.8	19.4	21.1
89	1	1/15/78	18.0	17.0	8.0	17.9
89	1	2/19/78	32.0	13.7	11.0	17.0
89	1	3/12/78	30.0	14.6	6.0	15.6
89	1	3/23/78	31.0	18.1	7.0	20.8
90	1	1/15/78	13.5	13.9	13.0	9.6
90	1	1/28/78	17.0	14.7	13.5	16.2
90	1	2/11/78	16.0	15.6	13.0	14.4
90	1	2/23/78	18.0	13.9	13.0	14.4
90	1	3/18/78	21.0	13.4	12.0	15.6
91	1	1/15/78	13.5	13.9	15.5	10.1
91	1	1/28/78	17.0	14.7	13.5	11.6
91	1	2/11/78	16.0	15.6	15.0	14.6
91	1	2/23/78	18.0	13.9	16.0	13.7
91	1	3/18/78	21.0	13.4	14.0	15.6
69	1	1/15/78	13.5	13.9	16.0	11.7
69	1	1/28/78	17.0	14.7	16.0	13.7
69	1	2/11/78	16.0	15.6	18.0	13.9
69	1	2/23/78	18.0	13.9	15.0	14.6
69	1	3/18/78	21.0	13.4	20.0	15.6
93	1	3/ 1/77	58.0	10.0	47.0	6.2
93	1	3/21/77	54.0	20.6	60.0	17.9
93	1	4/ 5/77	4.5	26.2	57.4	28.9
94	1	3/ 1/77	58.0	10.0	31.0	5.6
94	1	3/21/77	54.0	20.6	34.8	19.8
94	1	4/ 5/77	4.5	26.2	36.0	30.0
95	1	3/ 1/77	58.0	10.0	12.0	-1
95	1	3/21/77	54.0	20.6	30.0	21.8
95	1	4/ 5/77	97.0	18.3	50.0	19.7
96	1	3/ 1/77	26.0	8.7	25.0	5.0
96	1	3/21/77	36.5	22.5	21.0	22.7
97	1	3/ 1/77	34.0	11.4	26.0	5.0
97	1	3/21/77	36.5	22.5	35.6	18.8
97	1	4/ 5/77	48.0	31.2	40.0	29.6
98	1	3/ 1/77	34.0	11.2	31.0	9.4

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
98	1	3/21/77	36.5	22.5	25.5	20.6
99	1	3/ 1/77	24.0	9.4	17.0	10.0
99	1	3/22/77	26.3	22.9	0.0	0.0
100	1	3/ 1/77	24.0	9.4	8.0	2.5
100	1	3/22/77	26.5	22.9	15.3	25.0
101	1	3/ [illegible]/77	24.0	9.4	16.0	6.2
101	1	3/22/77	26.3	22.9	0.0	0.0
102	1	3/ 1/77	30.0	12.5	13.2	14.6
102	1	3/22/77	54.2	23.8	22.4	21.5
103	1	2/22/77	6.6	3.7	6.8	7.5
103	1	3/ 8/77	13.0	15.6	9.7	15.6
103	1	3/23/77	14.0	20.1	9.0	20.0
104	1	3/ 8/77	13.0	16.8	10.0	13.7
104	1	3/27/77	14.0	20.1	9.0	15.8
105	1	3/23/77	14.0	20.1	14.9	17.5
106	1	3/23/77	14.0	20.1	8.3	19.2
107	1	3/23/77	14.0	20.1	7.0	21.4
93	1	11/25/77	20.5	31.5	23.0	30.4
93	1	1/14/78	-1	-1	56.0	22.1
93	1	2/19/78	-1	-1	65.0	23.1
93	1	3/26/78	-1	-1	24.0	29.1
94	1	11/25/77	20.5	31.5	18.0	26.0
94	1	1/14/78	-1	-1	35.0	20.3
94	1	2/19/78	-1	-1	64.0	20.8
94	1	3/26/78	-1	-1	32.0	24.4
95	1	11/25/77	32.0	31.2	10.0	-1
95	1	1/14/78	-1	-1	24.0	27.5
95	1	2/19/78	-1	-1	40.0	21.4
96	1	11/25/77	9.0	17.8	0.0	0.0
96	1	1/14/78	9.0	31.2	0.0	0.0
96	1	2/19/78	23.0	27.4	0.0	0.0
97	1	11/25/77	9.0	17.8	0.0	0.0
97	1	1/14/78	9.0	31.2	6.0	-1
97	1	2/19/78	23.0	27.4	30.0	-1
98	1	11/25/77	9.0	17.8	0.0	0.0
98	1	1/14/78	9.0	31.2	6.0	-1
98	1	2/19/78	23.0	27.4	4.0	-1
99	1	2/19/78	9.0	20.8	0.0	0.0
100	1	2/19/78	9.0	20.8	11.5	28.4
101	1	2/19/78	9.0	20.8	0.0	0.0
102	1	2/19/78	69.0	29.4	24.0	21.6
103	1	11/25/77	15.0	22.7	12.0	17.0
103	1	2/18/78	20.0	16.4	8.0	19.3
104	1	11/25/77	15.0	22.7	0.0	0.0
104	1	2/18/78	20.0	16.4	11.0	15.6
105	1	11/25/77	15.0	22.7	0.0	0.0
105	1	2/18/78	20.0	16.4	11.2	17.0
106	1	11/25/77	15.0	22.7	0.0	0.0

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
106	1	2/18/78	20.0	16.4	15.0	19.2
107	1	11/25/77	15.0	22.7	10.0	20.8
107	1	2/18/78	20.0	16.4	10.0	18.4
108	1	1/ 4/77	7.0	14.4	6.0	20.5
108	1	1/14/77	-1	-1	6.0	15.3
108	1	1/25/77	13.0	14.6	6.0	16.2
108	1	2/ 7/77	13.0	15.9	5.0	20.6
108	1	2/15/77	8.0	24.3	4.5	26.8
108	1	2/21/77	9.5	17.0	4.0	16.5
108	1	3/18/77	9.0	13.1	3.0	10.6
108	1	3/23/77	6.0	13.1	4.0	15.9
109	1	1/ 4/77	7.0	14.4	5.0	20.1
109	1	1/14/77	-1	-1	4.0	16.2
109	1	1/26/77	13.0	14.6	4.0	18.1
109	1	2/ 7/77	13.0	15.9	3.0	18.7
110	1	1/ 4/77	7.0	14.4	1.5	18.0
110	1	1/14/77	-1	-1	3.0	15.0
110	1	1/26/77	13.0	14.6	4.0	20.0
110	1	2/ 7/77	13.0	15.9	3.5	15.0
111	1	1/ 4/77	7.0	14.4	6.0	9.4
111	2	1/ 4/77	7.0	14.4	4.0	17.3
111	1	1/13/77	-1	-1	8.0	23.0
111	2	1/13/77	-1	-1	3.0	17.8
111	1	1/26/77	13.0	14.6	9.0	18.0
111	2	1/26/77	13.0	14.6	4.0	14.4
111	1	2/ 8/77	13.0	15.9	5.0	19.0
111	2	2/ 8/77	13.0	15.9	4.0	19.4
111	1	2/15/77	8.0	24.3	3.5	22.5
111	2	2/15/77	8.0	24.3	0.0	0.0
111	1	2/21/77	9.5	15.0	3.0	10.1
111	2	2/21/77	9.5	15.0	2.5	13.7
111	1	3/18/77	9.0	13.1	5.0	11.2
111	2	3/18/77	9.0	13.1	2.0	11.8
111	1	3/23/77	6.0	13.1	3.0	14.2
111	2	3/23/77	6.0	13.1	3.0	14.4
112	1	1/ 4/77	7.0	14.4	4.0	-1
112	2	1/ 4/77	7.0	14.4	1.5	-1
112	3	1/ 4/77	7.0	14.4	1.5	-1
112	1	1/13/77	-1	-1	4.0	15.6
112	2	1/13/77	-1	-1	4.0	16.2
112	3	1/13/77	-1	-1	3.5	16.8
112	1	1/26/77	13.0	14.6	4.0	18.1
112	2	1/26/77	13.0	14.6	2.0	17.5
112	3	1/26/77	13.0	14.6	3.0	20.6
112	1	2/ 7/77	13.0	15.9	5.0	16.2
112	2	2/ 7/77	13.0	15.9	1.5	20.6
112	3	2/ 7/77	13.0	15.9	1.5	18.4
113	1	1/ 4/77	7.0	14.4	4.0	13.1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
113	2	1/ 4/77	7.0	14.4	1.5	13.1
113	1	1/12/77	-1	-1	4.0	18.9
113	2	1/12/77	-1	-1	2.5	17.0
113	1	1/25/77	14.0	14.1	5.0	19.8
113	2	1/25/77	14.0	14.1	2.0	19.8
113	1	2/ 8/77	20.0	16.5	4.0	21.3
113	2	2/ 8/77	20.0	16.5	2.5	18.0
114	1	1/ 4/77	7.0	14.4	8.0	19.6
114	1	1/12/77	-1	-1	4.0	15.8
114	1	1/25/77	14.0	14.1	3.5	19.4
114	1	2/ 7/77	20.0	16.5	5.0	20.6
114	1	2/15/77	11.0	26.2	-1	25.0
114	1	2/21/77	14.0	18.6	4.5	15.6
114	1	3/18/77	8.0	11.2	4.0	11.2
114	1	3/23/77	5.0	13.1	5.0	13.3
115	1	1/ 4/77	7.0	14.4	3.0	15.5
115	2	1/ 4/77	7.0	14.4	2.5	15.5
115	1	1/12/77	-1	-1	6.0	15.6
115	2	1/12/77	-1	-1	4.0	15.6
115	1	1/26/77	14.0	14.1	6.0	15.6
115	1	2/ 7/77	20.0	16.5	8.0	18.5
116	1	1/13/77	-1	-1	2.0	-1
116	1	2/ 9/77	16.0	16.9	1.0	23.1
214	1	1/ 4/77	7.0	14.4	2.0	13.1
117	1	1/ 7/77	7.0	14.4	3.0	16.1
117	1	1/13/77	-1	-1	10.0	17.7
117	1	2/ 7/77	10.0	14.4	8.0	20.4
117	1	2/15/77	8.0	22.5	6.0	25.0
118	1	1/ 7/77	7.0	14.4	1.3	-1
118	2	1/ 7/77	7.0	14.4	1.3	-1
118	1	1/13/77	13.0	-1	0.2	-1
118	2	1/13/77	13.0	-1	1.0	-1
118	1	2/ 9/77	10.0	14.4	0.0	0.0
118	2	2/ 9/77	10.0	14.4	4.0	18.8
118	1	2/15/77	8.0	22.5	0.0	0.0
118	2	2/15/77	8.0	22.5	0.0	0.0
118	1	2/21/77	15.0	17.9	-1	-1
118	2	2/21/77	15.0	17.9	-1	-1
119	1	1/ 7/77	7.0	11.4	1.3	-1
119	2	1/ 7/77	7.0	11.4	1.3	-1
119	1	1/13/77	13.0	-1	0.2	-1
119	2	1/13/77	13.0	-1	1.0	-1
119	1	2/ 9/77	10.0	14.4	0.0	0.0
119	2	2/ 9/77	10.0	14.4	0.0	0.0
119	1	2/15/77	8.0	22.5	0.0	0.0
119	2	2/15/77	8.0	22.5	0.0	0.0
119	1	2/21/77	15.0	17.9	0.0	0.0
119	2	2/21/77	15.0	17.9	-1	-1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
120	1	1/ 7/77	7.0	11.4	2.0	-1
120	1	1/13/77	13.0	-1	2.5	16.2
120	1	2/ 7/77	10.0	14.4	6.0	18.4
120	1	2/15/77	8.0	22.5	3.0	20.6
121	1	1/ 7/77	7.0	14.4	0.8	-1
121	1	1/13/77	13.0	-1	0.8	-1
122	1	1/19/78	5.0	29.3	4.0	15.0
122	1	2/ 6/78	11.0	14.2	4.5	12.3
123	1	12/23/77	1.0	-1	4.0	14.9
123	1	1/13/78	5.0	29.0	5.0	17.2
123	1	2/ 6/78	11.0	14.2	4.0	19.5
124	1	2/ 7/78	11.0	14.2	2.5	12.4
125	1	12/23/77	1.0	-1	4.0	12.9
125	1	1/13/78	5.0	29.0	3.0	14.6
125	1	2/ 6/78	11.0	14.2	7.0	20.1
126	1	12/23/77	1.0	-1	2.0	35.6
127	1	1/19/78	5.0	29.3	3.5	-0.1
127	1	2/ 7/78	11.0	14.2	5.5	9.2
128	1	1/19/78	5.0	29.3	3.0	11.8
128	1	3/15/78	5.0	34.6	3.5	20.4
129	1	11/23/77	3.5	10.8	3.0	9.9
129	1	12/30/77	6.0	19.8	4.0	14.7
129	1	1/ 4/78	7.5	13.1	1.0	10.6
129	1	2/15/78	2.5	6.6	2.0	12.4
130	1	11/23/77	3.5	12.2	0.0	0.0
130	2	11/23/77	3.5	12.2	2.0	11.2
130	1	12/30/77	6.5	15.4	0.0	0.0
130	2	12/30/77	6.5	15.4	3.0	9.3
130	1	1/ 4/78	6.0	14.7	0.0	0.0
130	2	1/ 4/78	6.0	14.7	2.0	14.4
130	1	2/15/78	3.0	7.1	0.0	0.0
130	2	2/15/78	3.0	7.1	1.0	40.0
131	1	11/23/77	4.0	8.7	3.5	11.7
131	1	12/30/77	6.0	10.3	2.5	14.9
131	1	1/ 4/78	8.0	14.4	0.0	0.0
131	1	2/15/78	2.0	4.4	1.5	14.3
132	1	11/23/77	5.0	9.6	4.0	9.7
132	1	12/30/77	6.5	12.7	5.5	16.5
132	1	1/ 4/78	7.0	15.0	5.5	15.3
132	1	2/15/78	3.5	8.0	3.0	9.2
133	1	11/23/77	3.5	10.3	3.0	7.1
133	1	12/30/77	6.0	16.5	4.0	10.5
133	1	1/ 4/78	8.0	13.1	1.0	-1
133	1	2/15/78	3.0	7.9	3.0	10.0
134	1	11/23/77	4.4	10.6	2.0	15.4
134	1	12/30/77	6.0	12.3	2.0	13.5
134	1	1/ 4/78	6.0	15.6	2.0	17.5
134	1	2/15/78	4.0	5.9	0.5	40.0

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
135	1	11/23/77	5.5	11.9	4.0	11.1
135	1	12/30/77	6.3	13.7	4.5	13.2
135	1	1/ 4/78	7.0	13.1	4.0	13.1
135	1	2/15/78	3.0	7.9	2.0	11.2
136	1	11/23/77	5.0	12.7	1.5	40.0
136	2	11/23/77	5.0	12.7	2.0	40.0
136	3	11/23/77	5.0	12.7	3.0	40.0
136	1	12/30/77	5.8	12.5	3.5	13.4
136	2	12/30/77	5.8	12.5	1.0	13.4
136	3	12/30/77	5.8	12.5	3.0	13.4
136	1	1/ 4/78	8.0	12.5	1.0	12.5
136	2	1/ 4/78	8.0	12.5	0.0	0.0
136	3	1/ 4/78	8.0	12.5	2.0	12.5
136	1	2/15/78	4.0	8.2	2.5	7.2
136	2	2/15/78	4.0	8.2	1.0	7.2
136	3	2/15/78	4.0	8.2	2.5	7.2
137	1	11/23/77	5.0	10.0	3.0	12.2
137	1	12/30/77	6.5	13.7	3.0	10.4
137	1	1/ 4/78	8.0	11.9	2.0	22.5
137	1	2/15/78	4.0	8.7	3.0	8.9
138	1	11/23/77	5.0	12.0	3.0	10.7
138	1	12/30/77	6.8	14.4	3.5	9.9
138	1	1/ 4/78	8.0	11.2	3.0	19.3
138	1	2/15/78	3.0	7.0	1.0	8.1
139	1	11/23/77	5.0	10.2	3.0	12.9
139	1	12/30/77	5.8	16.4	2.5	11.5
139	1	1/ 4/78	7.0	18.1	1.5	13.8
139	1	2/15/78	4.0	7.4	0.8	40.0
140	1	11/23/77	3.5	7.7	3.0	4.2
140	2	11/23/77	3.5	7.7	2.0	8.4
140	3	11/23/77	3.5	7.7	2.0	6.3
140	1	12/30/77	5.0	9.1	3.0	15.1
140	2	12/30/77	5.0	9.1	3.0	8.1
140	3	12/30/77	5.0	9.1	2.5	15.1
140	1	1/ 4/78	6.5	17.8	3.0	14.4
140	2	1/ 4/78	6.5	17.8	2.0	17.2
140	3	1/ 4/78	6.5	17.8	2.0	13.1
140	1	2/15/78	3.0	8.0	0.5	40.0
140	2	2/15/78	3.0	8.0	0.5	40.0
140	3	2/15/78	3.0	8.0	0.5	40.0
141	1	12/22/75	10.0	12.6	15.0	10.1
141	2	12/22/75	10.0	12.6	13.0	10.1
141	1	12/27/75	6.0	14.1	7.0	12.8
141	2	12/27/75	6.0	14.1	7.0	12.8
141	1	3/ 3/76	4.0	20.3	3.0	19.8
141	2	3/ 3/76	4.0	20.3	3.0	19.8
141	1	3/18/76	10.0	10.8	10.0	11.1
141	2	3/18/76	10.0	10.8	12.0	11.1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
142	1	12/22/75	10.0	10.6	10.0	9.1
142	1	3/ 3/76	4.0	22.0	3.0	22.8
142	2	3/ 3/76	4.0	22.0	3.5	22.8
142	3	3/ 3/76	4.0	22.0	4.0	22.8
142	1	3/18/76	10.0	9.8	10.0	10.3
142	2	3/18/76	10.0	9.8	7.0	10.3
142	3	3/18/76	10.0	9.8	6.0	10.3
143	1	12/22/75	10.0	11.3	6.0	10.8
143	2	12/22/75	10.0	11.3	8.0	10.8
143	1	12/27/75	6.0	15.1	3.0	14.8
143	2	12/27/75	6.0	15.1	5.0	14.8
143	1	3/ 3/76	4.0	21.6	3.0	21.1
143	2	3/ 3/76	4.0	21.6	4.0	21.1
143	1	3/18/76	10.0	8.8	3.0	8.6
143	2	3/18/76	10.0	8.8	6.0	8.6
144	1	12/22/75	10.0	11.3	6.0	9.8
144	2	12/22/75	10.0	11.3	10.0	9.8
144	1	12/27/75	6.0	15.1	5.0	15.6
144	2	12/27/75	6.0	15.1	7.0	15.6
144	1	3/ 3/76	4.0	21.6	3.0	21.3
144	2	3/ 3/76	4.0	21.6	4.0	21.3
144	1	3/18/76	10.0	8.8	3.5	9.6
144	2	3/18/76	10.0	8.8	10.0	9.6
145	1	12/22/75	10.0	9.4	6.0	9.3
145	2	12/22/75	10.0	9.4	7.0	9.3
145	1	3/ 3/76	4.0	22.1	3.0	21.6
145	2	3/ 3/76	4.0	22.1	4.0	21.6
145	1	3/18/76	9.0	10.3	7.0	9.8
145	2	3/18/76	9.0	10.3	5.0	9.8
146	1	12/27/75	6.0	14.5	5.0	14.0
146	2	12/27/75	6.0	14.5	10.0	14.0
146	3	12/27/75	6.0	14.5	6.5	14.0
146	1	3/ 3/76	4.0	22.8	2.0	22.1
146	2	3/ 3/76	4.0	22.8	4.0	22.1
146	3	3/ 3/76	4.0	22.8	4.0	22.1
146	1	3/18/76	10.0	10.1	4.0	9.3
146	2	3/18/76	10.0	10.1	9.0	9.3
146	3	3/18/76	10.0	10.1	4.0	9.3
147	1	12/27/75	8.0	16.1	5.0	14.8
147	2	12/27/75	8.0	16.1	3.0	14.8
147	1	3/ 3/76	4.0	22.8	3.0	22.1
147	2	3/ 3/76	4.0	22.8	4.0	22.1
147	1	3/18/76	10.0	10.8	3.0	10.1
147	2	3/18/76	10.0	10.8	3.0	10.1
148	1	12/24/75	10.0	12.1	8.5	10.0
148	1	1/13/76	9.0	11.7	15.0	11.6
148	1	2/ 4/76	7.0	17.9	4.0	17.4
148	1	3/18/76	10.0	9.8	8.0	9.1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
149	1	12/24/75	7.0	12.3	5.0	11.8
149	2	12/24/75	7.0	12.3	1.0	11.8
149	3	12/24/75	7.0	12.3	6.0	11.8
149	1	1/13/76	12.0	13.7	8.0	10.0
149	2	1/13/76	12.0	13.7	1.0	10.0
149	3	1/13/76	12.0	13.7	8.0	10.0
149	1	2/ 4/76	5.0	19.2	3.0	13.3
149	2	2/ 4/76	5.0	19.2	0.0	0.0
149	3	2/ 4/76	5.0	19.2	6.0	13.3
149	1	3/18/76	8.0	11.0	4.0	10.1
149	3	3/18/76	8.0	11.0	6.0	10.1
150	1	12/27/75	7.0	14.8	4.0	16.6
150	2	12/27/75	7.0	14.8	3.0	16.6
150	3	12/27/75	7.0	14.8	2.5	16.6
150	1	2/ 4/76	5.0	14.3	2.0	14.0
150	2	2/ 4/76	5.0	14.3	1.5	14.0
150	3	2/ 4/76	5.0	14.3	1.0	14.0
150	1	3/18/76	8.0	10.6	2.5	10.8
150	2	3/18/76	8.0	10.6	2.5	10.8
150	3	3/18/76	8.0	10.6	2.5	10.8
151	1	12/23/75	10.0	10.5	5.0	14.1
151	1	1/14/76	8.0	24.1	0.0	0.0
151	1	2/ 4/76	3.0	13.6	1.5	52.0
151	1	3/17/76	9.0	10.3	2.0	10.6
152	1	12/23/75	10.0	10.5	5.0	11.6
152	1	1/14/76	8.0	24.1	4.0	21.5
152	1	2/ 4/76	3.0	13.6	6.0	12.5
152	1	3/17/76	9.0	10.0	8.0	10.3
153	1	12/24/75	7.0	12.8	5.0	13.6
153	2	12/24/75	7.0	12.8	5.0	13.6
153	1	1/14/76	8.0	24.1	2.0	21.3
153	2	1/14/76	8.0	24.1	5.0	21.3
153	1	2/ 4/76	3.0	13.8	6.0	12.8
153	2	2/ 4/76	3.0	13.8	6.0	12.8
153	1	3/17/76	9.0	10.5	5.0	10.8
153	2	3/17/76	9.0	10.5	4.0	10.8
154	1	12/24/75	7.0	12.8	4.0	12.6
154	1	1/14/76	9.0	22.4	1.5	-1
154	1	2/ 4/76	3.0	14.3	2.5	14.3
154	1	3/17/76	9.0	10.6	1.5	10.1
155	1	12/23/75	9.0	11.1	5.0	11.3
155	1	1/14/76	8.0	24.3	2.0	25.8
155	1	2/ 4/76	3.0	13.1	3.0	13.3
155	1	3/17/76	9.0	10.3	5.0	11.1
156	1	3/17/76	8.0	11.0	4.0	12.6
156	2	3/17/76	8.0	11.0	6.0	12.6
157	1	12/23/75	9.0	9.8	7.0	9.0
157	1	2/ 4/76	3.0	12.8	6.0	13.0
157	1	3/17/76	9.0	8.5	9.0	7.8
158	1	12/23/75	9.0	11.5	4.0	15.0
158	1	2/ 4/76	3.0	13.5	2.0	13.3
158	1	3/17/76	9.5	10.1	4.0	9.5
159	1	12/23/75	9.0	11.6	6.0	10.6
159	1	2/ 4/76	3.0	13.3	3.0	13.8
159	1	3/17/76	9.0	10.6	4.0	10.5
160	1	2/ 4/76	3.0	12.0	2.0	12.8
160	2	2/ 4/76	3.0	12.0	1.0	12.8
160	1	3/17/76	9.0	10.1	2.0	9.6
151	1	1/11/77	8.0	10.8	3.0	13.3
151	1	2/24/77	7.0	20.5	2.0	23.8
152	1	1/11/77	8.0	13.1	4.0	15.1
152	1	1/25/77	6.0	22.6	6.0	19.1
152	1	2/24/77	7.0	19.3	3.0	23.0
153	1	1/11/77	8.0	10.6	8.0	11.6
153	2	1/11/77	8.0	10.6	8.0	11.6
153	1	1/25/77	6.0	22.6	4.0	13.3
153	2	1/25/77	6.0	22.6	5.0	23.3
153	1	2/24/77	7.0	22.8	7.0	22.6
153	2	2/24/77	7.0	22.8	7.0	22.6
154	1	1/11/77	8.0	10.6	4.0	12.1
154	1	1/25/77	6.0	21.3	1.0	24.3
154	1	2/24/77	7.0	20.8	2.0	24.1
155	1	1/11/77	8.0	10.5	8.0	10.3
155	1	2/24/77	7.0	21.3	3.0	23.3
156	1	1/11/77	8.0	12.0	5.0	14.8
156	2	1/11/77	8.0	12.0	10.0	14.8
156	1	2/24/77	7.0	22.8	2.0	27.1
156	2	2/24/77	7.0	22.8	3.0	27.1
157	1	1/11/77	8.0	12.3	6.0	13.3
157	1	1/25/77	6.0	14.5	4.0	16.3
157	1	2/24/77	7.0	22.1	4.0	21.8
158	1	1/11/77	8.0	14.8	3.0	14.6
158	1	2/24/77	7.0	19.0	2.0	18.8
161	1	1/11/77	8.0	11.6	6.0	16.1
161	1	2/24/77	7.0	16.1	3.0	20.8
162	1	1/12/77	8.0	12.8	15.0	22.3
162	2	1/12/77	8.0	12.8	3.0	22.3
162	3	1/12/77	8.0	12.8	8.0	22.3
163	1	1/24/77	7.0	16.3	2.0	12.3
149	1	1/14/77	8.0	12.8	8.0	17.8
149	2	1/14/77	8.0	12.8	3.0	17.8
149	3	1/14/77	8.0	12.8	7.5	17.8
149	1	2/10/77	8.0	12.8	5.0	20.9
149	2	2/10/77	8.0	12.8	1.0	20.9
149	3	2/10/77	8.0	12.8	5.0	20.9
148	1	1/14/77	8.0	12.8	8.0	14.3

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
148	1	2/10/77	8.0	14.8	9.0	20.6
141	1	1/14/77	8.0	15.6	4.0	17.6
141	2	1/14/77	8.0	15.6	5.0	17.6
141	1	2/10/77	8.0	15.1	2.0	22.1
141	2	2/10/77	8.0	15.1	2.0	22.1
147	1	1/14/77	8.0	12.8	4.5	13.8
147	2	1/14/77	8.0	12.8	5.0	13.8
147	1	2/10/77	8.0	16.1	3.0	21.1
147	2	2/10/77	8.0	16.1	1.5	21.1
142	1	1/14/77	8.0	11.0	4.0	12.1
142	2	1/14/77	8.0	11.0	4.5	12.1
142	3	1/14/77	8.0	11.0	4.5	12.1
143	1	1/14/77	8.0	19.3	4.0	14.1
143	2	1/14/77	8.0	19.3	5.0	14.1
143	1	2/10/77	8.0	14.8	4.0	18.8
143	2	2/10/77	8.0	14.8	4.0	18.8
144	1	1/14/77	8.0	13.3	5.0	13.5
144	2	1/14/77	8.0	13.3	6.0	13.5
144	1	2/10/77	8.0	12.6	4.0	20.0
144	2	2/10/77	8.0	12.6	4.0	20.0
145	1	1/14/77	8.0	12.5	4.0	12.5
145	2	1/14/77	8.0	12.5	7.0	12.5
146	1	1/14/77	8.0	18.1	3.0	14.3
146	2	1/14/77	8.0	18.1	9.0	14.3
146	3	1/14/77	8.0	18.1	5.0	14.3
165	1	1/10/77	9.0	12.3	6.0	20.0
165	1	2/10/77	9.0	16.1	9.0	16.0
165	1	2/22/77	11.0	9.8	6.0	9.6
166	1	1/10/77	9.0	10.8	7.0	11.5
166	1	2/10/77	9.0	14.6	6.0	23.8
166	1	2/22/77	11.0	9.1	5.0	9.1
167	1	1/10/77	9.0	12.1	3.0	15.6
167	1	2/10/77	9.0	10.5	4.0	12.0
168	1	1/10/77	9.0	10.3	6.0	16.3
168	1	2/10/77	9.0	17.0	3.0	19.1
169	1	1/10/77	9.0	9.6	6.0	16.6
169	1	2/10/77	9.0	14.5	2.5	16.6
170	1	1/10/77	9.0	7.6	5.0	17.8
170	1	2/10/77	9.0	14.0	3.0	15.3
171	1	12/18/76	10.0	19.8	10.0	17.6
171	2	12/18/76	10.0	19.8	11.0	17.6
171	1	3/30/77	12.0	26.1	0.0	0.0
171	2	3/30/77	12.0	26.1	6.0	27.3
172	1	12/18/76	10.0	19.8	12.0	17.1
172	1	3/30/77	12.0	26.1	0.0	0.0
173	1	12/18/76	10.0	19.8	12.0	18.5
173	1	3/30/77	12.0	26.1	0.0	0.0
174	1	12/18/76	10.0	14.8	7.0	11.1

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
174	1	3/30/77	12.0	24.9	0.0	0.0
175	1	12/18/76	10.0	14.8	8.0	11.1
175	1	3/30/77	12.0	24.9	0.0	0.0
176	1	12/18/76	10.0	13.3	10.0	17.6
176	1	3/30/77	12.0	25.3	4.0	25.6
177	1	12/18/76	10.0	18.6	8.0	20.3
177	2	12/18/76	10.0	18.6	5.0	20.3
177	1	3/30/77	12.0	22.3	5.0	28.0
177	2	3/30/77	12.0	22.3	4.0	28.0
178	1	2/25/77	24.0	23.5	21.0	18.0
179	1	2/25/77	30.0	22.3	29.0	23.2
180	1	2/25/77	30.0	24.1	30.0	23.0
181	1	2/25/77	32.0	23.6	24.0	18.8
182	1	2/25/77	21.0	19.3	15.0	17.1
183	1	2/25/77	21.0	22.6	15.0	19.1
201	1	12/18/76	10.0	14.9	0.0	0.0
201	2	12/18/76	10.0	14.9	0.0	0.0
201	3	12/18/76	10.0	14.9	0.0	0.0
201	1	3/30/77	10.0	24.9	0.0	0.0
201	2	3/30/77	10.0	24.9	0.0	0.0
201	3	3/30/77	10.0	24.9	0.0	0.0
202	1	12/18/76	10.0	14.9	0.0	0.0
202	1	3/30/77	12.0	24.9	0.0	0.0
203	1	12/18/76	10.0	14.9	0.0	0.0
203	1	3/30/77	12.0	24.9	0.0	0.0
204	1	12/18/76	10.0	14.9	0.0	0.0
204	1	3/30/77	12.0	24.9	0.0	0.0
205	1	12/18/76	10.0	14.9	0.0	0.0
205	1	3/30/77	12.0	24.9	0.0	0.0
206	1	12/18/76	10.0	14.9	0.0	0.0
206	1	3/30/77	12.0	24.9	0.0	0.0
207	1	12/18/76	10.0	14.9	0.0	0.0
207	1	3/30/77	12.0	24.9	0.0	0.0
208	1	12/18/76	10.0	14.9	0.0	0.0
208	1	3/30/77	12.0	24.9	0.0	0.0
209	1	12/18/76	10.0	14.9	0.0	0.0
209	2	12/18/76	10.0	14.9	0.0	0.0
209	1	3/30/77	12.0	24.9	0.0	0.0
209	2	3/30/77	12.0	24.9	0.0	0.0
210	1	12/18/76	10.0	14.9	0.0	0.0
210	1	3/30/77	12.0	24.9	0.0	0.0
211	1	12/18/76	10.0	14.9	0.0	0.0
211	1	3/30/77	12.0	24.9	0.0	0.0
151	1	1/18/78	12.0	15.1	8.0	14.3
151	1	2/13/78	10.0	14.6	2.0	18.3
152	1	1/18/78	12.0	14.0	8.0	13.5
152	1	2/ 1/78	5.0	18.8	6.0	17.5
152	1	2/13/78	10.0	15.6	10.0	15.5

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft^3)	Roof snow depth (in.)	Roof snow density (lb/ft^3)
153	1	1/18/78	12.0	12.0	11.0	12.8
153	2	1/18/78	12.0	12.0	7.0	12.8
153	1	2/ 1/78	4.0	18.3	3.0	18.6
153	2	2/ 1/78	4.0	18.3	5.0	18.7
153	1	2/13/78	8.0	15.0	6.0	11.6
153	2	2/13/78	8.0	15.0	8.0	11.6
154	1	1/18/78	12.0	13.1	8.0	14.1
154	1	2/13/78	9.0	18.5	2.0	17.6
155	1	1/18/78	12.0	12.6	10.0	12.1
155	1	2/ 1/78	5.0	18.1	4.0	18.1
155	1	2/11/78	10.0	16.3	6.0	13.8
156	1	1/19/78	13.0	15.6	12.0	16.3
156	2	1/19/78	13.0	15.6	20.0	16.3
156	1	2/ 3/78	5.0	19.5	4.0	21.0
156	2	2/ 3/78	5.0	19.5	10.0	21.0
156	1	2/11/78	11.0	14.8	8.0	17.1
156	2	2/11/78	11.0	14.8	12.0	17.1
157	1	1/19/78	13.0	10.6	14.0	10.5
157	1	2/ 3/78	5.0	18.6	4.0	19.3
157	1	2/11/78	12.0	15.0	6.0	13.8
158	1	1/19/78	13.0	12.8	7.0	14.1
158	1	2/ 3/78	5.0	22.1	2.0	16.8
158	1	2/13/78	10.0	14.5	4.0	15.3
161	1	1/19/78	13.0	14.3	11.0	13.8
161	1	2/ 3/78	6.0	20.8	4.0	17.3
161	1	2/11/78	10.0	15.1	6.0	16.8
184	1	12/27/77	6.0	20.3	3.0	18.4
184	2	12/27/77	6.0	20.3	3.0	18.4
185	1	12/27/77	6.0	19.8	7.5	16.1
185	1	1/28/78	20.0	13.8	12.0	14.6
185	1	3/11/78	16.0	14.8	8.0	16.0
186	1	12/27/77	6.0	19.6	3.5	17.8
187	1	12/27/77	6.0	17.1	3.5	18.1
187	2	12/27/77	6.0	17.1	3.5	18.1
187	3	12/27/77	6.0	17.1	3.5	18.1
187	1	1/28/78	20.0	14.5	0.0	0.0
187	2	1/28/78	20.0	14.5	6.0	15.8
187	3	1/28/78	20.0	14.5	9.0	15.8
187	1	3/11/78	14.0	20.3	0.0	0.0
187	2	3/11/78	14.0	20.3	5.0	18.6
187	3	3/11/78	14.0	20.3	5.0	18.6
188	1	12/27/77	6.0	18.5	3.0	17.3
188	1	1/28/78	29.0	14.5	2.5	46.9
189	1	12/29/77	8.0	18.6	5.0	19.0
189	1	1/29/78	15.0	14.8	7.0	15.6
190	1	12/29/77	7.0	18.6	6.0	19.6
190	2	12/29/77	7.0	18.6	6.0	19.6
190	3	12/29/77	7.0	18.6	6.0	19.6
190	1	1/29/78	15.0	15.8	6.0	22.0
190	2	1/29/78	15.0	15.8	9.0	22.0
190	3	1/29/78	15.0	15.8	10.0	22.0
190	1	3/11/78	15.0	16.6	6.0	20.1
190	2	3/11/78	15.0	16.6	8.0	20.1
190	3	3/11/78	15.0	16.6	8.0	20.1
191	1	1/29/78	15.0	12.1	4.0	13.0
192	1	12/27/78	6.0	18.6	4.0	17.3
192	1	1/28/78	15.0	17.3	5.0	18.3
192	1	3/11/78	13.0	16.3	2.0	18.1
193	1	12/27/77	6.0	17.1	5.0	21.8
193	1	1/28/78	15.0	16.6	3.0	13.8
194	1	12/27/77	8.0	19.6	9.0	18.3
194	1	1/28/78	22.0	15.1	8.0	17.8
194	1	3/18/78	20.0	16.8	10.0	16.8
195	1	12/29/77	6.0	19.6	4.0	19.8
195	1	1/29/78	13.0	17.3	4.0	16.8
196	1	12/27/77	4.0	20.1	2.0	18.2
196	2	12/27/77	4.0	20.1	3.0	18.2
196	3	12/27/77	4.0	20.1	0.0	0.0
196	4	12/27/77	4.0	20.1	0.0	0.0
197	1	12/27/77	4.0	18.8	6.0	15.6
197	1	1/28/78	12.0	15.3	12.0	15.6
197	1	3/11/78	10.0	15.6	10.0	15.3
198	1	12/27/77	4.0	17.8	4.0	18.0
198	1	1/28/78	12.0	15.8	8.0	13.3
198	1	3/11/78	10.0	16.6	8.0	15.8
199	1	12/27/77	6.0	18.6	3.0	20.1
199	1	1/28/78	20.0	14.6	7.0	17.8
199	1	3/11/78	14.0	17.8	6.0	19.5
200	1	12/29/77	7.0	18.6	12.0	17.1
200	2	12/29/77	7.0	18.6	12.0	17.1
200	1	1/29/78	15.0	14.0	17.0	15.8
200	2	1/29/78	15.0	14.0	19.0	15.8
200	1	3/11/78	16.0	16.8	16.0	16.5
200	2	3/11/78	16.0	16.8	18.0	16.5
171	1	1/22/78	40.0	5.6	30.0	7.1
171	2	1/22/78	40.0	5.6	30.0	7.1
171	1	2/20/78	32.0	12.3	25.0	11.8
171	2	2/20/78	32.0	12.3	34.5	11.8
171	1	3/19/78	28.0	17.3	21.0	21.5
171	2	3/19/78	28.0	17.3	21.0	21.5
172	1	1/22/78	40.0	5.6	36.0	7.1
172	1	2/20/78	32.0	12.3	36.0	11.8
172	1	3/19/78	28.0	17.3	24.0	21.5
201	1	1/22/78	38.0	6.1	30.0	7.5
201	2	1/22/78	38.0	6.1	30.0	7.5
201	3	1/22/78	38.0	6.1	30.0	7.5

Structure no.	Roof no.	Date	Ground snow depth (in.)	Ground snow density (lb/ft³)	Roof snow depth (in.)	Roof snow density (lb/ft³)
201	1	2/20/78	32.0	13.6	13.0	12.3
201	2	2/20/78	32.0	13.6	13.0	12.3
201	3	2/20/78	32.0	13.6	20.0	12.3
201	1	3/19/78	28.0	15.8	10.0	16.6
201	2	3/19/78	28.0	15.8	10.0	16.6
201	3	3/19/78	28.0	15.8	13.0	16.6
174	1	1/22/78	38.0	6.1	36.0	7.5
174	1	2/20/78	32.0	13.6	24.0	10.1
174	1	3/19/78	28.0	15.8	21.0	16.1
202	1	1/22/78	36.0	6.5	12.0	7.1
203	1	1/22/78	36.0	6.5	30.0	7.1
204	1	1/22/78	36.0	6.1	30.0	7.5
204	1	2/20/78	27.0	14.8	14.0	13.8
204	1	3/19/78	22.0	19.8	8.0	20.8
205	1	1/22/78	34.0	5.3	10.0	8.0
205	1	2/20/78	20.0	14.1	6.0	14.1
205	1	3/19/78	20.0	18.8	5.0	17.8
206	1	1/22/78	34.0	5.3	21.0	8.0
206	1	2/20/78	20.0	14.1	12.0	13.8
206	1	3/19/78	20.0	18.8	4.0	18.5
207	1	1/22/78	36.0	6.3	20.0	7.5
207	1	2/20/78	25.0	16.5	6.0	16.8
207	1	3/19/78	22.0	18.3	8.0	18.8
208	1	1/22/78	36.0	6.3	24.0	7.5
208	1	2/20/78	25.0	16.5	6.0	16.3
208	1	3/19/78	22.0	18.3	3.0	20.6
209	1	1/22/78	38.0	6.1	30.0	7.5
209	2	1/22/78	38.0	6.1	30.0	7.5
209	1	2/20/78	32.0	19.3	12.0	20.1
209	2	2/20/78	32.0	19.3	13.0	20.1
209	1	3/19/78	26.0	17.6	7.0	21.6
209	2	3/19/78	26.0	17.6	5.0	21.6
210	1	1/22/78	40.0	5.6	38.0	6.1
210	1	2/20/78	36.0	15.3	36.0	10.3
210	1	3/19/78	32.0	22.1	28.0	20.0
176	1	1/22/78	42.0	6.6	42.0	6.8
176	1	2/20/78	36.0	11.8	36.0	15.6
176	1	3/19/78	32.0	18.6	20.0	22.8
211	1	1/22/78	42.0	7.0	42.0	8.0
211	1	2/20/78	36.0	12.1	36.0	11.6
211	1	3/19/78	32.0	19.8	26.0	18.5
177	1	1/22/78	38.0	6.0	30.0	7.4
177	2	1/22/78	38.0	6.0	36.0	7.4
177	1	2/20/78	30.0	11.8	26.0	12.8
177	2	2/20/78	30.0	11.8	26.0	12.8
177	1	3/19/78	29.0	16.0	16.0	18.5
177	2	3/19/78	29.0	16.0	26.0	18.5

APPENDIX D. CONVERSION FACTORS FROM THE 1982 ANSI STANDARD.

Table D1. Wind exposure factor C_e.

Category	*Siting of structure**	C_e
A	Windy area with roof exposed on all sides with no shelter afforded by terrain, higher structures or trees.†	0.8
B	Windy areas with little shelter available.†	0.9
C	Normal siting. Snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures or several trees nearby.	1.0
D	Areas that do not experience much wind and where terrain, higher structures or several trees shelter the roof.†	1.1
E	Densely forested areas that experience little wind with roof located tight in among conifers.	1.2

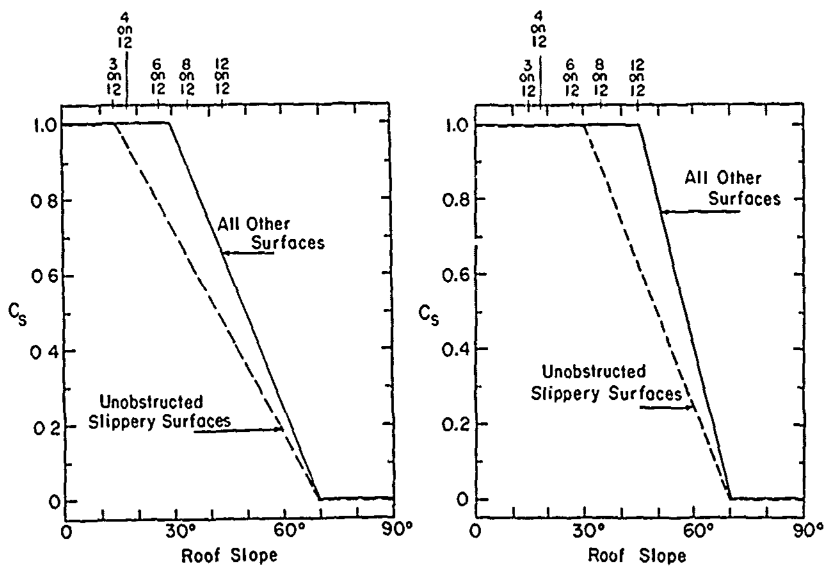
*The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

†Obstructions within a distance of $10h_0$ provide "shelter," where h_0 is the height of the obstruction above the roof level. If the obstruction is created by deciduous trees, which are leafless in winter, C_e may be reduced by 0.1.

Table D2. Thermal factor C_t.

*Thermal condition**	C_t
Heated structure	1.0
Structure kept just above freezing	1.1
Unheated structure	1.2

*These conditions should be representative of those that are likely to exist during the life of the structure.



a. *Warm roofs (C_t = 1.0).* b. *Cold roofs (C_t > 1.0).*

Figure D1. C_s versus roof slope.

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Bibliography: p. 11.
1. Builuing codes. 2. Building standards. 3. Roofs. 4. Snow loads. 5. Structural design.

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